Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

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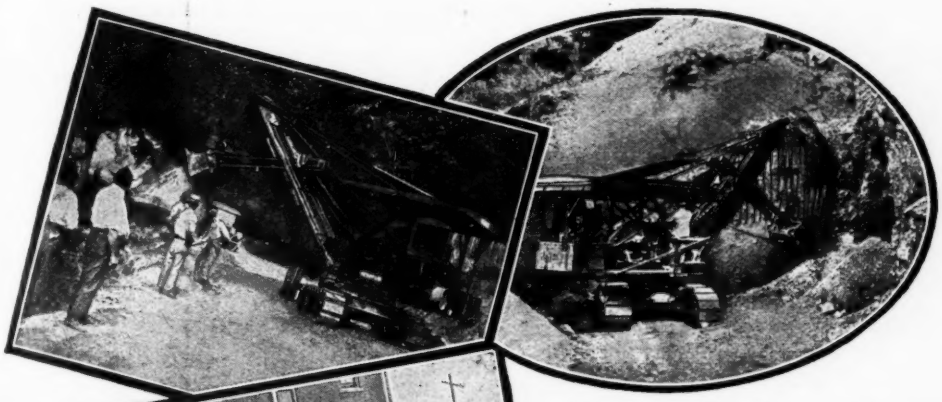

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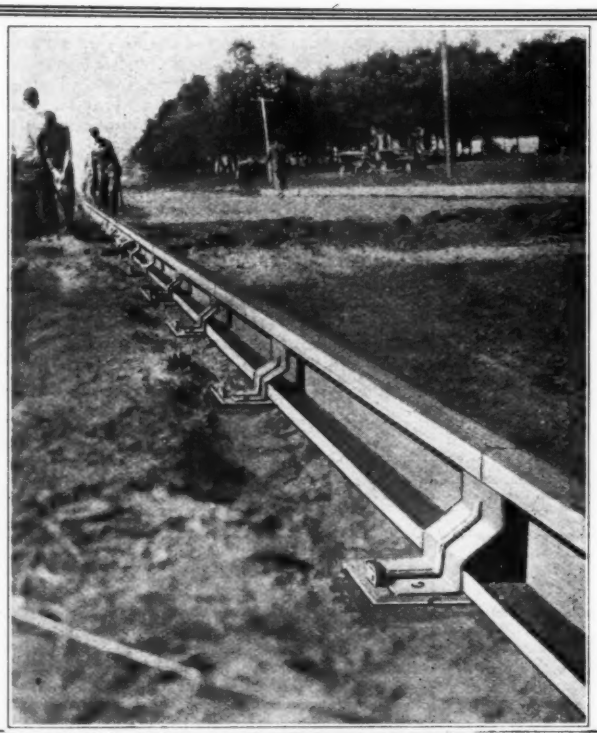

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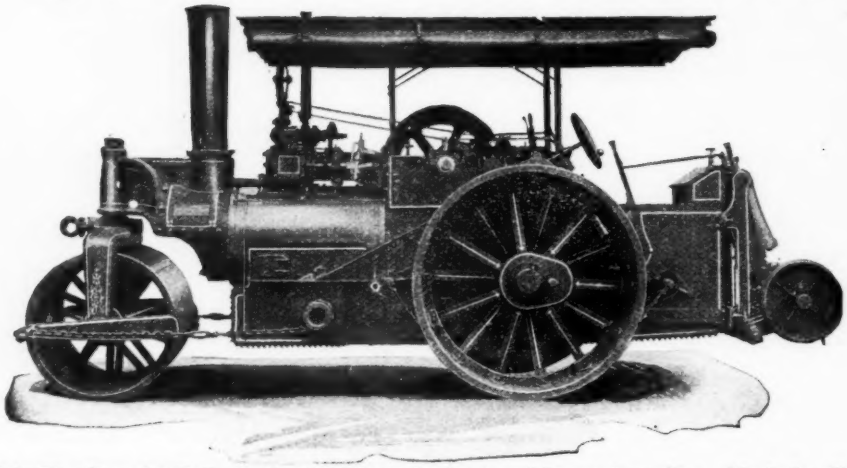

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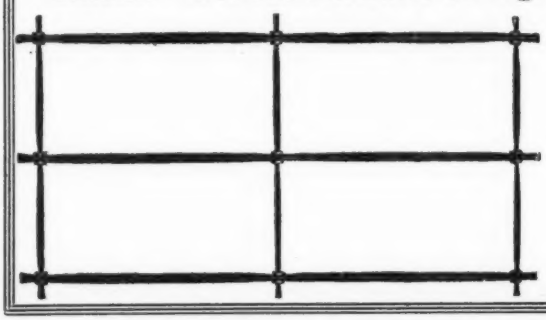

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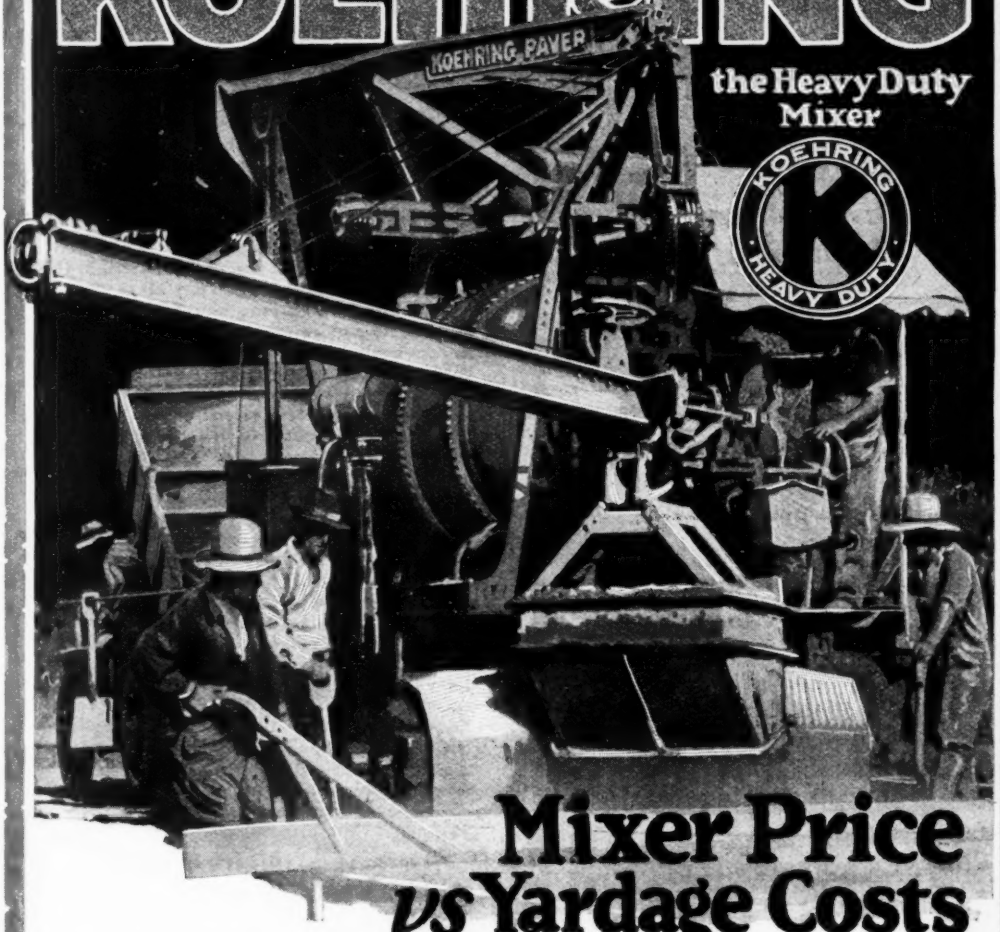

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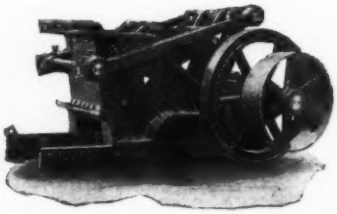

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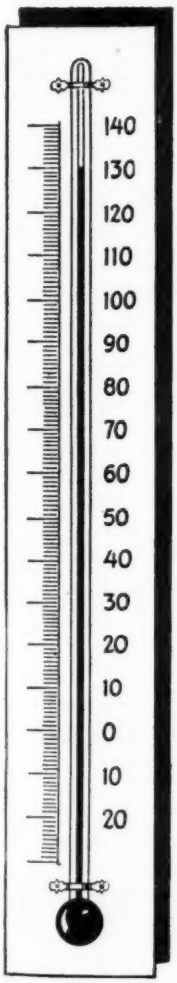

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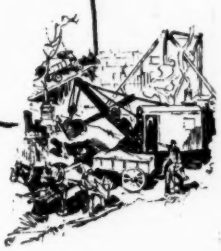

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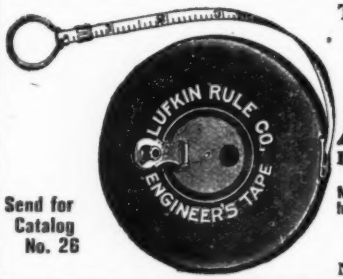

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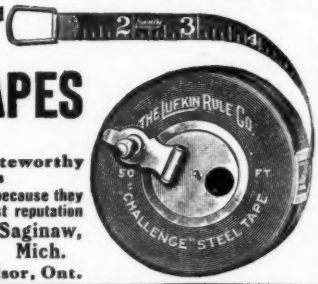

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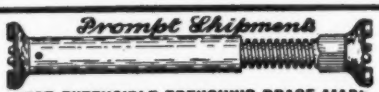

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For Sale at an attractive price, an Iroquois 2-unit portable asphalt plant; 3,000-gallon steam heated kettle; rated capacity, 800 yards, but has done 1,000 yards per day. Practically new; has done only one job of about 40,000 yards. The price should be very attractive to any contractor or city in the market for an asphalt plant.

Address Box M—Municipal and County Engineering

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Motor Truck Operation and Accounting—84

HUSTLING YOUNG CONTRACTOR AVERAGES OVER 1,000 FT. OF 18 FT. CONCRETE ROAD PER DAY

To the Editor:

A first class organization and a keen interest shown on the part of each workingman is the cause of the splendid record which is being made by J. P. Connell, a young contractor of Janesville, in Southern Wisconsin.

On May 15th work was started on seven miles of concrete in Jefferson County, Wisconsin, and up to date over six miles have been completed. During this time work has been delayed about twelve whole days, due to rains and four days' delays which were necessitated by moving equipment from one town to another.

The material is shipped in and unloaded from cars by a clam-shell and dumped into a Kissel specially designed hopper. This hopper is operated by one man and with a turn of a lever will fill a truck with two batches of sand and gravel in three seconds.

The truck leaves the hopper and is driven to a cement car stationed on a side track nearby where the required number of cement sacks are emptied into the truck on top of the sand and gravel. They then speed to the scene of operation where one hundred or more feet in front of the mixer the truck is turned around on a Kissel turn-table and is then in a position to back up the sub-grade to the 5-bag mixer where the batch is mixed and dumped on the grade. A finishing machine, operated by one man, keeps up with the mixer.

Eight Kissel trucks with specially designed batch boxes have kept the mixer on the go from morning till night.

In order to avoid tie-ups, which many times happen from delayed freight, a store-pile, which holds 75 cars of sand and gravel, is kept beside the hopper. A day and night shift keep the material unloaded and therefore no worry is experienced when the gravel pits, many miles away, are unable to make shipments.

The interest taken by the people in the community, as well as that of the workmen, has much to do with the success of this work. At the completion of each day's work the number of feet of concrete laid causes great interest and discussion as to whether or not more feet can be laid on the day following.

On July 19th, the wind-up of a five-mile stretch of 18 ft. concrete, 1,118 ft. were laid in 11½ hours. In a period of five days just previous to this, 5,136 ft. of concrete were laid.

This contractor has taken four miles more of concrete road and expects to have the work completed this fall. This includes culverts, grading, shouldering and everything that has to do with the completion of the road.

This work received a very high compliment a few days ago from the Portland Cement Association Inspector.

Very truly yours,
R. D. ROYCE, County Highway Com.
Jefferson, Wis., July 26, 1922.

TEXT OF COLORADO DECISION AFFECTING COMMERCIAL USE OF HIGHWAYS

(Editor's Note:—Quotations from the decision of the Public Utilities Commission of the State of Colorado, affecting the commercial use of highways in that State, have been widely published. We present the full text of the decision herewith for the convenience of our many readers who are interested in the use of highways. It is important to study all regulatory measures, even if they are only local in scope, while a general policy of highway commercial traffic regulation is in the first stages of formulation.

The specific case covered by this decision has not been adjudicated in any other Colorado court, and this decision of the Commission had not yet been appealed to any other tribunal on July 22, 1922, according to a letter written us on that date by Mr. Charles H. Small, Secretary of the Commission.

The decision is given in full for the thoughtful consideration of readers. We do not believe in the suppression of news, even if the news is not entirely to our liking. The specific case on which this decision was based is comparatively unimportant and of no great interest to the public. But some of the Commission's generalizations seem rather sweeping and

dangerous to the development of the commercial use of highways. If some of these generalizations are used as precedents by similar regulatory bodies hardships to individuals and communities will result.

Regulation in some form must come but it must be fair and eventually will be fair. To keep out injustice during the formulative period, which may be ruinous to many firms and individuals, we hope the best minds in the motor industry will take hold of this general subject and assist in placing it speedily in a position where justice will be done all parties. We will welcome discussion of the subject for publication.)

The decision, No. 518, Application No. 134, was rendered on March 8, 1922. Decision was rendered: In the Matter of the Application of Ralph McGlochlin for a Certificate of Public Convenience and Necessity for the Operation of an Automobile Passenger and Freight Line between Glenwood Springs and State Bridge, Colorado, via Wolcott.

Statement by Commission

The application herein was filed with this Commission April 25, 1921, and was set down for hearing and was heard in the Hearing Room at the State Capitol, Denver, Colorado, Thursday, Jan. 19, 1922.

Alexander R. Baldwin, receiver of the property of The Denver and Rio Grande Western Railroad Company, by his attorneys, E. N. Clark and Thomas R. Woodrow, filed, May 10, 1921, protest on behalf of the railroad company against the granting of a certificate under this application. Since the filing of the protest, the Receiver has been discharged and the railroad has passed into the hands of The Denver and Rio Grande Western Railroad Company.

The applicant, Ralph McGlochlin, asks that the Commission grant him a certificate of convenience and necessity for the establishment and operation of an automobile passenger line between Glenwood Springs and State Bridge, via Wolcott, all of which points are within the confines of Garfield and Eagle counties, Colorado. The proposed line, starting at Glenwood Springs, would run over the State highway through Garfield county, to the county line in Eagle county, thence through Eagle county through the towns of Dotsero, Gypsum, Eagle and Wolcott and terminate at State Bridge, Colorado, on the Denver and Salt Lake Railroad.

More than $600,000 has been expended on about 15 miles of State highway through the canyon, along the Colorado river, east of Glenwood Springs. It forms an important link in the highways between eastern Colorado and Utah and California and for scenic beauty is unsurpassed in the western country.

It was brought out at this hearing that the petitioner intended to limit the operation of his auto busses to only four months in the year; namely, June, July, August and September, when he could operate at the minimum of expense and maximum of profit.

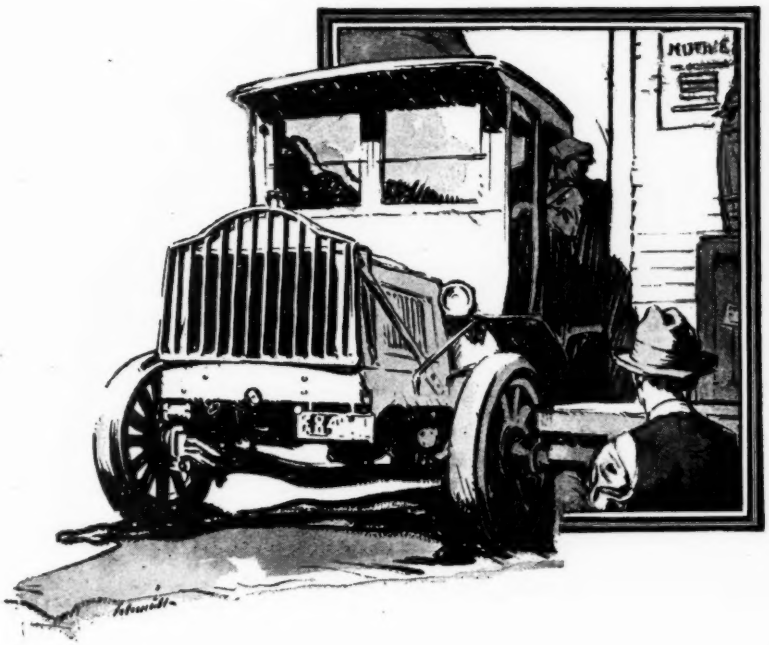
This service is claimed to be not only a convenience but a necessity as well. Obviously when roads are muddy in spring and fall and also when deep snows have to be contended with by the traveling public in winter, it is at these times, if ever, when passenger conveyances become not only a convenience but an absolute necessity as well. Right at this time is when this applicant proposes to cease to function as a common carrier, which leads this Commission to the conclusion that this certificate is sought not so much to meet the conveniences and necessities of the traveling public as it is for private gain.

This hearing brought out the fact that this railroad company actually loses money on its through travel, while the profitable haul comes from its local passenger travel. Even at this, the fare by rail from Wolcott to Glenwood Springs is only $2.22, while the applicant proposes to charge $3.00, by auto bus, between the same points.

One of the important reasons alleged for a certificate, by this applicant, was the fact that No. 1, the "Scenic Limited" of the Denver and Rio Grande Western, did not stop at Wolcott, thus compelling passengers coming over from State Bridge and bound westward to remain over night at Wolcott and pay hotel bills. Feb. 28, 1922, the railroad company issued an order, effective at once, that train No. 1 will stop on flag at Wolcott for passengers, so that this feature of the argument for a certificate has been elimited.

The evidence introduced in this case shows that the railroads in Colorado paid in 1921 *State road taxes* aggregating $159,875.42. Of this amount The Denver and Rio Grande Western Railroad contributed for roads for the 1921 period, $45,207.12. In 1921 this road paid in taxes in Eagle county $61,240.09, and of this amount The Denver and Rio Grande Western contributed to the county road tax of said Eagle county, $16,709.89.

The testimony also shows that The Den-



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The owners of thousands of Packard Trucks all over America, chose them for no other reason than their proven merit;—an intensely significant fact for all who are now, or will be, in the market for motor trucks.

This soundly founded preference for the Packard Truck is made even more pronounced by its price—recognized to be not only eminently fair, but also lower than that of other trucks of comparable quality.

Packard Trucks range in capacity from 2 tons to 7½ tons; and in price from $3,100 to $4,500

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In 585 Cities and towns throughout the United States, Packard Truck Service stations give owners highly skilled service at a reasonable cost. Packard Truck costs, always low because the sound Packard construction minimizes the need of repair, are held still lower by this expert, broadcast service.

PACKARD TRUCKS

ver and Rio Grande Western Railroad Company paid Garfield county in 1921 taxes to the amount of $92,656.85, and of this amount $21,314.05 was for the upkeep and construction of roads.

The vehicle registration report of Colorado, compiled by the Secretary of State, for 1921, shows that Eagle county had seven trucks and paid in revenue to the State the sum of $54.25. Also, that Garfield county had 61 trucks and paid into the State treasury $765.02, or a total for the two counties of only $819.27 for the use of the State and county highways that the trucks use, while The Denver and Rio Grande Western Railroad had to pay in the same two counties, for the same period, more than forty-six times as much, or $38,023.94 for the roads they do not use at all.

As to the adequacy of service for the town of Wolcott, we find No. 16 eastbound Denver and Rio Grande Western train makes a regular stop at Wolcott at 6:06 p. m. No. 4, also eastbound, stops on flag at 11:59 p. m., while No. 2 eastbound at 7:55 a. m. stops on flag to discharge passengers from Glenwood Springs and points west. There is also a freight train, No. 94, eastbound daily, excepting Sunday, that picks up and discharges passengers at all stations between Glenwood Springs and Wolcott.

Westbound No. 15 stops on flag at Wolcott at 9:28 a. m. to pick up passengers for Eagle, Gypsum, Glenwood Springs and other intermediate points as far as Grand Junction. No. 3 westbound has a flag stop at Wolcott at 4:36 a. m. and has a regular stop at Eagle and a flag stop at Gypsum and a regular stop at Glenwood Springs and all other points of considerable importance as far as Grand Junction. No. 1, the Scenic Limited, also stops on flag at Wolcott at 8:45 p. m., thus taking care of passengers from State Bridge, whose destination is westward on The Denver and Rio Grande Western. In addition to the aforesaid service, freight train No. 93 leaving Wolcott daily, excepting Sunday, at 1:38 p. m., picks up and discharges passengers at all stations westward and arrives in Glenwood at 5:20 p. m.

Taking into consideration the size of the town of Wolcott and the fact that the traveling public have access to three trains in each direction on Sunday and that there are four available trains both east and west every other day in the year, it would seem that there is no need for additional passenger service between Glenwood Springs and Wolcott. In fact, we believe these people are far better off than those of many more populous communities in not only this but other states as well. A reflex of the conditions is found in the fact that the total ticket sales from Wolcott to all points west, including Glenwood Springs, for 1921, amounted to only $664.77.

The record in this case shows The Denver and Rio Grande Western, in 1921, paid in Garfield and Eagle counties taxes totalling $153,896.94 and that over $38,000 went into the road fund of these counties. Viewing this whole matter from the point of present adequacy of transportation facilities and in the light of a decent regard for the rights of others, it would seem inequitable and unjust that the vast sums wrung from the railroads, especially in the shape of road taxes, should be used to provide means to encompass their own destruction.

Looking at all the facts in this case, it would seem manifestly unfair for this Commission to grant a certificate to this applicant that he may skim off the cream of the passenger traffic during the summer months and then leave the railroad to battle with the elements during the balance of the year when railroad operations are a heavier financial burden and passenger travel is exceedingly light.

But leave the railroad entirely out of the case and view it only from the standpoint of the farmer and city home owner. They pay a very large proportion of taxes assessed for highway construction and maintenance. Some of them own and operate automobiles and some do not. If they do, the damage to roads from the occasional operation of their light, pneumatic tired cars is practically negligible. They seldom use the roads under weather conditions such that their use is destructive, while at certain seasons the heavily loaded freight and passenger trucks plough back and forth making great furroughs in the road regardless both of conditions and consequences. Under weather conditions producing softened roadbeds, the passage of a single heavily loaded truck will do greater damage to a highway than would the passage of hundreds of ordinary cars. The farmer and the city home owner pays the bills and the 136,336 passenger car owners of the State are grievously wronged.

Public convenience and necessity, by which must be understood the convenience and necessity of the people at large as contra-distinguished from the convenience

and necessity of a very small number of persons who seek to derive a profit from the farmers' and home owners' investment in roads, never contemplated that the truck driver should destroy that, to the cost of construction of which he contributed little or nothing, or that he should reap where he has not sown.

When the taxing laws of this State are so amended that the truck driver operating over state highways shall contribute his due proportion to the cost of construction and maintenance of our highways, then, and not until then, can this Commission regard his use, under proper conditions and restrictions, of a great and tremendously expensive public facility as of equal dignity and equal benefit to the people with the moderate use thereof by the ordinary taxpayer.

Viewing this case in all its aspects, this Commission finds there is no existing necessity for an auto bus passenger line between Glenwood Springs and Wolcott. It also finds that the service furnished by The Denver and Rio Grande Western Railroad Company between Glenwood Springs and Wolcott is fully adequate to meet the reasonable necessities of the traveling public during the entire year.

The Colorado Public Utilities Act limits the Commission's authority over the issuance of certificates of convenience and necessity to automobiles in competition with railroads. As there is no such competition between Wolcott and State Bridge, the Commission holds it has no authority over this part of the route.

For the aforesaid reasons, this Commission will deny the prayer of the applicant for a certificate for that part of the proposed route between Wolcott and Glenwood Springs on the grounds that there is no necessity shown to exist for such automobile passenger line.

Order

IT IS THEREFORE ORDERED, That the application of Ralph McGlochlin for a certificate of convenience and necessity for the operation of an automobile passenger line between Glenwood Springs and State Bridge, Colorado, be, and the same is, hereby denied over any and all that portion of the proposed route between Glenwood Springs and Wolcott, Colorado.

FEDERAL FAST EXPRESS TRUCKS ON MARKET

The first of the recently announced Federal Fast Express Trucks left the Federal Motor Truck Company, Detroit, Tuesday afternoon, bound for Milwaukee, Wis. The first 50 trucks of this new model will be driven from the factory by dealers, leaving the factory in varying numbers each day.

The report of the driver of the first new model has just been received at the factory. It bubbles with enthusiasm. One hundred fifty-two miles were covered the first day, a stop being made for the night at Paw Paw, Mich.

"To my surprise, when I opened the gas tank," continues the report, "for the last lap of my journey the next day, I found that I still had a few gallons of gasoline (the tank only holding 12½ gallons), giving me a little better than 15 miles to the gallon.

"My lubricating oil gauge showed better than ¾ full, but I chucked in a quart for good measure and did not put any more in on the trip, neither did I put a drop of water in the radiator during the entire trip."

Leaving Paw Paw at 8 o'clock Wednesday morning, the writer states he arrived in Milwaukee shortly before 9 o'clock in the evening. So pleased was he with the truck that he took the purchaser out that same night for a spin. "She sure is the snappiest little bus I ever rode in, and am sure glad I waited for it," was the way the customer described it.

The second Fast Federal Express to leave the factory made the 204 miles to Columbus, Ohio, in 9 hours 40 minutes, using ½ gal. of oil and 15½ gals. of gasoline.

FINANCING OUR FUTURE HIGHWAYS

"Plan now the financing of highways for the future and place highway transportation, which has come to be an indispensable part of our national life, on a firm foundation." This is the advice given by Thomas H. McDonald, Chief of the Bureau of Public Roads, United States Department of Agriculture, for the consideration of every voter, taxpayer and legislator.

"We are starting out to construct a system of highways such as no nation ever constructed before. The nearest approach to it is found in France and Germany, and the area of neither is as large as Texas. This great undertaking is being entered into because highways are not a luxury but furnish a real service,

have a real earning capacity, and have become a national necessity.

"For such an undertaking to be successful, financing to care for maintenance, reconstruction, and new construction should be planned for a long period of years in advance. Changes in methods of raising funds every few years, uncertainty as to whether funds will be provided, and periods in which funds are not provided, all increase the final cost of highways. Such a policy would soon bring any private business to disaster.

"Development and increase in numbers of motor vehicles and the coincident need and demand for good roads have come so rapidly that methods of raising funds have often been expedients for the time being. Consideration has been given not so much to the just distribution of the cost as to how the funds can be raised with the least controversy and the utmost ease. Then, too, the use made of the highways and the service rendered by them has changed greatly within the last few years.

"All this leads to the conclusion that the whole situation should be gone over very carefully, traffic studies made, and the cost distributed in proportion to the service rendered.

"The Bureau of Public Roads estimates that of the $600,000,000 spent for highways last year 33 per cent was federal aid and motor vehicle revenue. The remaining 67 per cent comes either directly or will eventually be paid from state and local taxes. It is believed that a very considerable readjustment of the source of revenues must be made so that a larger percentage will be paid by the road user and a lesser percentage from state or local taxes."

PERMANENT INTERNATIONAL ASSOCIATION ROAD CONGRESSES

The Executive Committee of the Permanent International Association of Road Congresses announces that the Fourth International Road Congress will be held in Seville, Spain, in May, 1923. The Congress will be in session for six days.

The object of the Association is to promote and record progress in the improvement of highways and the efficient development of highway transport throughout the world. The work of the Association consists in organizing and conducting International Road Congresses, publishing the proceedings of its Congresses and other documents, and collecting information relative to highway improvement and highway transport. A bulletin of the Association is issued four times each year. The bulletin contains complete minutes of the meetings of the Permanent International Commission and the Permanent Council, announcements by the Executive Bureau, and progress reports on highway engineering and highway transport practice throughout the world. Each member, who resides in the United States, receives copies of the English editions of all proceedings, bulletins and other literature published by the Association.

The membership of the Association consists of representatives of governments and corporations, and individual members. The business affairs of the Association are managed by the Permanent International Commission, which is composed of members representing the various governments having membership in the Association. Each government has the right to one representative for each 1,000 francs of its total annual subsidy, provided that the number of representatives from any one government does not exceed 15. Unfortunately, the United States Government is the only world power which has not been affiliated with the Association.

The First International Road Congress was held in Paris in 1908. At this Congress, the Permanent International Association of Road Congresses was formed with headquarters in Paris. The Second Congress was held in Brussels in 1910. Following the Second Congress, the Permanent International Commission adopted a resolution to the effect that an International Congress should be held every three years. The world war, of course, interfered with this program after 1913.

The Third International Road Congress was held in London in 1913 and was attended by 3,793 members, of which 139 were from the United States. Fifty-two nations were represented at the Congress, 44 governments having official representatives. The business sessions of the Congress occupied about one week and were devoted to a thorough discussion of 149 reports pertaining to the 19 topics on the program of the Congress. During the final business session, progressive conclusions relative to every main topic were adopted by the Congress. The reports, which were presented by reporters from 19 nations, and the proceedings of the Third Congress measure, when stacked, about 6½ ins. by 9½ ins. by 8 ins. in height.

CONTRACT AWARDED ON IDEAL SECTION OF LINCOLN HIGHWAY

The far-famed stretch of model road known as the Ideal Section of the Lincoln Highway is, after nearly two years of preliminary research and detailed work, now under construction in Lake County, Indiana.

The contracts for the construction were closed recently in Indianapolis, when Stone & Webster, Inc., of Boston, Mass., acting as agents for the Lincoln Highway Association, undertook to build a section of road which will cost, with all appurtenances, approximately $100,000 a mile, at a price of $33,000 per mile to the State of Indiana. Stone & Webster, under whose supervision the work will proceed, let the construction contract to J. C. O'Connor & Sons of Fort Wayne, Ind. Already the work on this stretch, which will perhaps be one of the most talked-about and studied sections of highway in the world, is under way.

In addition to the $33,000 per mile provided by the State, Lake County authorities have assured $25,000 from the County funds and steps have already been taken by the County Council and Commissioners to provide this sum as the County's share. The extra expense of the Section beyond the sum supplied by the State and County, which is equivalent to what the construction of the usual state specifications would cost, will be met by the Lincoln Highway Association, through a special fund provided by the United States Rubber Company. It is expected that the paving work will be completed by the end of October, many details including the lighting installation; the beautification of the right-of-way, etc., remaining for accomplishment in the spring of 1923.

In the design of this unique section of the Lincoln Highway is embodied the mature thought of 15 of the foremost experts in highway enginering and construction and related problems in the United States who, acting without recompense as the Technical Committee of the Lincoln Highway Association, developed the general plan which was carried to detailed completion through the collaboration of the enginering department of the Indiana State Highway Commission, C. Gray, State Highway Engineer, Lockwood, Greene & Company, Engineers, and W. G. Thompson, formerly State Highway Engineer of New Jersey, the Association's Consulting Highway Engineer. Federal Aid of $20,000 per mile has been allowed by the Bureau of Public Roads of the Department of Agriculture, toward this construction, the development of which will be closely followed by the Federal authorities.

The ideas embodied in the design of the Ideal Section which will stand for years at its central location on the Lincoln Highway as a model for the gradual evolution of the entire route as traffic volume increases, impress many important lessons through which the Association hopes to inform and mould public opinion of the United States. The design calling for 40 ft. of 10-in. reinforced concrete pavement, capable of carrying a traffic of 20,000 vehicles per 24-hour day, one-quarter of which are estimated to be heavily laden trucks, impresses the necessity of permanency in our modern, highway investments on main routes of travel. The width makes for safety and facility of operation. The absence of drainage ditches at the side of the road further inculcates the safety idea, while the night illumination increases the road efficiency by permitting a heavy volume of night traffic without danger. The beautification of the roadside is in line with steps now being taken by the most advanced highway departments, which are realizing that too little attention has been given in this country to the importance of a proportionately small expenditure to realize the greatest beauty of the roadside.

While it is not expected that many states can undertake, in the near future, improvements embodying all of the principal elements of the Ideal Section design, it is felt by the Lincoln Highway Association and the officials of the United States Rubber Company, which made the object lesson section possible, that the design will be suggestive and will tend to bring to the attention of the American public the vital necessity of adequacy in present day specifications, if the hundreds of millions which are now going into highway construction are to properly serve the America of today and tomorrow.

FELLOWSHIPS IN HIGHWAY ENGINEERING AND HIGHWAY TRANSPORT

Two of the following Fellowships will be awarded not later than September 1 and two not later than November 1, 1922, by the Board of Regents of the University of Michigan.

The Roy D. Chapin Fellowship in Highway Transport, which is offered to pro-

vide for the investigation of an approved subject relative to highway transport.

The Roy D. Chapin Fellowship in Highway Engineering, which is offered to provide for the investigation of an approved subject relative to hard surfaced roads and pavements.

Two Detroit Edison Fellowships in Highway Engineering, which are offered to provide for the investigation of approved subjects relative to moderate cost country roads.

General conditions: Each Fellowship pays the sum of $250 with an allowance of $50 for expenses. The holders of these Fellowships do not have to pay tuition fees. A Fellow must hold a Bachelor's degree from a college of recognized standing. He must enroll as a graduate student in highway engineering or highway transport and as a candidate for the degree of Master of Science or Master of Science in Engineering. He must be in residence for one of the following periods: First semester (October to February), winter period (December to March), second semester (February to June). An application for a Fellowship must include a concise statement of the candidate's educational training and engineering experience, and three references. Applications and requests for information pertaining to the 25 advanced courses in Highway Engineering and Highway Transport offered by the graduate school should be sent to Professor Arthur H. Blanchard, Engineering Building, University of Michigan, Ann Arbor, Mich.

DECIDED IMPROVEMENT IN ENGINEERING EMPLOYMENT

A gradual and steady advance in engineering employment in all sections of the country with increased activity in many basic industries is reported by the employment department of the American Association of Engineers. The building industry has been most active. There have been some irregularities in manufacturing. The coal mining and railroad fields show a slight setback, due possibly to labor difficulties, but technical men are in demand. Highway and municipal work are progressing with added vigor, and employers in these fields find it difficult to locate experienced men. The demand for architectural and structural draftsmen and designers with building or plant experience has far exceeded the supply in practically all sections of the country.

Employment conditions for engineers in most territories are normal or very nearly so. The Southwest reports a scarcity of mechanical and structural men. California reports that students for summer employment are the only men available. Missouri reports normal conditions with calls for structural engineers predominating. Employers in eastern cities where usually more men are available are experiencing difficulty in finding capable engineers, with the possible exception of the District of Columbia.

The total number of positions being received by the American Association of Engineers is over 400 each month, with about 250 of these filled by the Association. This large placement is due to concerted local activity by capable employment representatives. The average monthly salary of all positions filled during June was $192. A number of positions above the $500 mark were filled.

While the general conditions are better at this time than they have been for over two years, there is still some irregularity, but the main trend shows improvement supported by prospects of further gain. Added reasons for more hopeful feeling appear in the continued increase in the operation of the iron and steel industry, the diminishing of unemployment of skilled and unskilled labor, and the active progression of building operations.

There is usually a summer letup in business, but this does not apply so much to engineering employment, for highway and municipal and other construction work is most active at this time. Authorities on economic problems are predicting that there will be considerable activity, increased production, and increased work this fall.

POLICE CHIEFS WANT WIDER ROADWAYS

Following close upon the action of the recent Good Roads Congress in Chicago which, in a resolution, declared for a minimum width of 20 ft. for highways, in deference to increasing traffic, the National Convention of police chiefs, held in San Francisco, recently adopted a resolution demanding wider streets and roads so as to facilitate the regulation of traffic. In cities like New York, Chicago, Boston, Providence, and others, narrow streets not only induce accidents but are big factors in traffic tie-ups. A committee was appointed at the convention to work for a uniform, nation-wide code of traffic signals and regulations.

EDITORIALS

LESSONS IN COAL AND RAIL STRIKES

Whatever the outcome of the coal and rail strikes of 1922, they teach a lesson of vital interest to engineers and to the general public. That lesson is that we should develop water power to make the coal interests behave and we should develop highways and highway transport to make the rail interests behave. Legislative remedies do not seem to effect cures in industrial crises; we should place our dependence in a system of economic checks and balances.

Time was when one part of the people took sides with the miners and the remaining part of the people took sides with the operators in coal strike embroglios. A third group has appeared and it is growing rapidly in size and influence. The viewpoint of the latter group was well expressed editorially in the *Chicago Tribune* for July 31, 1922:

"We think the whole mining strike crisis is bunk, a play staged at the public expense for the profit of operators and miners alike. Perhaps we are wrong, but it is our conviction that neither operators nor mine workers' leaders are in any danger of 'breaking up' until the breaking up is arranged. When the strike has got desired results in wiping out our coal reserves and the public is ready to take coal at a fat profit to owners, then peace will come on satisfactory terms to the miners, and the curtain will ring down until the next performance. That is bringing capital and labor together with a vengeance. Only the rest of us have small reason to applaud the show. We are not very optimistic about legislative remedies for our recurrent coal troubles. But there are some important economic measures which ought to be applied. They all may be comprehended in one word, water power."

The editorial goes on to advocate the development of such great water powers as those of the Tennessee and Illinois rivers and the St. Lawrence seaway.

Strikes do not usually occur when wages are low and large numbers of men are idle, but when labor is scarce and wages are high. The greatest epidemic of strikes the country ever experienced came when wages were very high and every man who was able and willing to work had a job. If the great water powers of the country are fully developed, water power, present and ready to serve, will have a strong tendency to prevent coal crises. Coal has been able to get away with everything, including murder, because it is at present so essential. If it can be made less essential in large and important industrial districts it will lose much of its present power to inflict paralysis, deprivation and suffering on the general public.

It has been demonstrated that the federal government can not break up these crises until the "breaking up" is due to occur anyway. In this connection many press references have recently been made to the action of President Roosevelt in "forcing a settlement" of the coal strike of twenty years ago. This incident is firmly established as a part of the Roosevelt legend and for legendary purposes the best possible interpretation is made of it. While we appreciate the purpose of wholesome legends they do more harm than good when they encourage us to attempt the impracticable. Doubtless many will recall that the strike president Roosevelt "settled" continued from early May until late October. By that time, previous efforts of the President having come to naught, the operators were ready to listen to reason, the men already having obligingly consented to arbitration. The President "forced" the operators to arbitrate; obviously they were ready to be forced in view of the fact that winter was at hand, etc. It is instructive to recall, also, that that was only an anthracite strike; quite a different thing from a general coal strike. With an abundance of soft coal everywhere available anthracite was in reality a non-essential; undoubtedly this assisted in the "forcing" process. With great water powers developed all coal would sink, in its mischief making powers, to a level not far above that now occupied by anthracite in the coal industry.

What we have said about water power

and coal may be said also about highway transportation and rail transportation. The railway shopmen's strike of this year, to date, has been a very tame affair compared with what we would experience if all the men who actually run the trains should quit their jobs at the same time, as they threatened to do in recent years. The best possible check on the railroads, in fact the only practicable one as we see it, is to develop a nation-wide system of highway transportation. With adequate highways in every locality a general rail strike could be viewed by the public with such a degree of equanimity that it probably would not occur at all.

It is not held that the development of water power and highway transportation will put an end to all coal and rail crises, but such developments will give the public substantial protection against the misfortunes now arising from a suspension of coal and rail service.

We believe we have pointed out the direction in which the public interest lies and we hope the engineer will continue to lead the way thither.

BELATED RATE INCREASES

Many public utilities struggled along during the war, and for some time thereafter, at pre-war rates despite tremendous increases in the cost of everything the utilities had to buy. At length some rate increases were granted and this has so incensed the public that in some states, Illinois and Indiana, for example, there has been much talk of abolishing the state public service commissions entirely.

The trouble arose primarily from the fact that the rates were not raised soon enough; not soon enough to do justice by the utilities and not soon enough to be accepted gracefully by the public. Had the rates been increased when costs of all commodities were rapidly rising this would have been taken more or less as a matter of course by the public and a minimum of friction would have developed. But it was not until prices had started to decline that rate increases were granted and this produced a maximum of friction. The public was unable to see why utility rates should go up when other prices were declining. This is a most unfortunate situation and great injustice has been done many utilities.

We are not disposed to be very critical of the state utility commissions for past mistakes of judgment but we hope they will take the lesson of this experience very much to heart and be guided by it in future. They were too optimistic about a general decline in prices which might obviate the necessity of rate increases. The expected relief from this source did not come up to expectations.

The statisticians tell us that commodity prices are again on the increase. The weighted average of 404 commodities, which are combined to form the wholesale price index of the Bureau of Labor Statistics, has increased eight points in the past year, the figure for June, 1922, being 150 against 142 for June, 1921, both expressed in per cent of the 1913 average.

The utilities must earn a fair return on their investment or they cannot be expected to maintain adequate service indefinitely. We hope the commissions will have the courage to grant rate increases where this should be done, even in the face of adverse criticism. If rising prices now make readjustments especially necessary we hope that account will also be taken, in formulating new rate schedules, of the fact that utility rates have been, generally, too low for the past seven or eight years.

RECIPROCAL HIGHWAY COURTESY

Every user of the highway has his rights and with these rights go obligations to respect the rights of others.

A special obligation rests upon the motor truck. It is precisely because the truck is big and strong enough to crowd other forms of traffic off the highway that it must not do so, but must conform to the rules of the road. Trucks usually move slowly and, like all slow moving traffic, should keep well to the side of the road or turn out to let faster traffic pass when signalled to do so. Trucks are noisy and truck drivers do not always hear horn signals promptly, so every truck should be equipped with a mirror to warn the driver of the presence of traffic behind him. The truck driver can not afford to be discourteous as drivers of passenger cars, if prejudiced against trucks, will join the ranks of those who would keep trucks off the highways or destroy their economic usefulness by drastic restrictions of one sort or another. This point is becoming well appreciated in motor circles. Recently the Indiana State Highway Commission ordered drivers of state trucks to take a course of instruction in road courtesy before being

allowed on the roads with a truck. This policy should be adopted, also, in the case of drivers of commercial trucks. The National Automobile Chamber of Commerce has also been urging the importance of courtesy in the driving of trucks, pointing out that driver discourtesy lessens the truck's economic prestige and must not be tolerated as it creates public opinion antagonistic to highway transport.

While trucks are amply able to take care of themselves on good roads they sometimes get into difficult positions on bad roads where they are at a momentary disadvantage. In such cases the truck should be the beneficiary of highway courtesy. For example, it may not be safe for a truck loaded with live stock to turn out immediately, to let a passenger car pass, when on a narrow road with steep sloping sides. The passenger car driver should then follow the truck patiently until a place in the road is reached where it is safe for the truck to turn out.

Courteous drivers of vehicles of any kind will follow up promptly all personal injury cases regardless of who is at fault, will drive at moderate speed, will avoid taking chances, will give ample warning to pedestrians or vehicles about to be passed, will recognize the fact that pedestrians have prior rights at crossings, and will be especially watchful of children playing on the roadway.

The safe as well as the efficient and agreeable use of the highway requires that each class of highway traffic recognize the peculiar rights of every other class.

DESIGN AND CONSTRUCTION OF SIX-SPAN REINFORCED CONCRETE HIGHWAY BRIDGE CROSSING WABASH RIVER AT ATTICA, INDIANA

By H. A. Hanapel, Resident Engineer, Indiana State Highway Commission, Hazelton, Indiana.

The Adeway, an important link in the transportation facilities of the State of Indiana, crosses the Wabash river at the foot of Mill street at Attica, Fountain county. The old structure, built in 1886, consists of two pony approach spans and five through trusses, total length 804 ft. The substructure consists of stone piers.

A Heavy Traffic Bridge

On account of the large amount of traffic, both through and local, the light superstructure has been greatly overstressed and was found inadequate safely to carry the loads. The floor system, being made up of wood stringers with a plank runway, was a source of great annoyance and danger to the traffic and an item of great expense of maintenance to the county. The substructure is in fair shape, but it is evident that the foundations do not extend much below the bed of the stream, if any at all.

It was realized for a number of years by the public as well as the local officials that it would be necessary to do something in order to continue to handle the traffic safely. The matter of repairing the old structure was investigated; however, it did not appear to be economical to attempt to use any part of it. The members of the trusses were not heavy enough to permit increasing the dead load by using steel stringers and adding a concrete floor. Besides the old steel showed evidence of being crystallized and therefore unfit for further use. The entire structure had outlived its usefulness.

After due deliberation on the part of the county officials, it was decided to build a new structure on the upstream side of the old one and as near to the latter as conditions would permit. Of all of the designs submitted, the one by Mr. Wm. J. Titus, Bridge Engineer of the Indiana State Highway Commission, was accepted as being the most economical and the best suited to the natural conditions. The contract was awarded to Standish & Allen of Chicago on February 7, 1920, on a unit price basis for the sum of $272,000.

The design is a six-span reinforced concrete arch, total length 986 ft. The individual spans vary in length from 135 to 150 ft. clear opening, having a rise of 16 ft., 3½ ins., to 19 ft., 11 ins. The arches are solid, with 12-in. sidewalls and counterforts supporting cantilevered brackets and a 6-in. sidewalk. The roadway provides a 20-ft. driveway, curb to curb, with a 5-ft. clear sidewalk on each side.

Foundations

The contractor started work in August, 1920, at the east end of the structure at abutment "A." The material excavated was an old cinder fill to elevation 495.00 (low water elevation 490.00) and a coarse gravel from this elevation to the final foundation, elevation 491.00. The contractor rigged up a mule traveler at this foundation and used it to drive the Wakefield sheeting and foundation piling. A total of 88 piling aggregating 2,015.7 lin. ft. below cut off (they were allowed to

project 18 ins. into the concrete) were driven.

After completing this foundation, the mule traveler was moved out to the first pier, "B," at the east edge of the water, and open dredged the hole before the cofferdam was placed. This foundation was carried down 13 ft. below low water through hard cemented gravel and then, 117 piling aggregating 2,123.9 lin. ft. were driven through the water by means of a follower made out of a hickory pile with a 30-in. long wrought iron pipe at one end. A Vulcan No. 2 steam hammer was used throughout. After the piling were all driven, the contractor received permission to seal the hole without unwatering it. In an attempt to use a tremie, the gang made a complete failure of it and after about 10 or 12 yds. were placed, the work was rejected and the contractor was ordered to unwater the hole and remove all of the concrete poured.

The following pumps were then set up at the foundation—one 8x6-in. centrifugal, one 10-in. double suction centrifugal, and a 7-in. Nye. The first two mentioned did not work properly and the three together could not unwater the hole. A 14x12-in. electric pump was then set up and it unwatered the hole in 20 minutes. About this time the river which had been at a low stage, started rising, and the 20-ft. Wakefield sheeting was found to be too short; therefore, it became necessary to build a puddle dam 4 ft. high above the sheeting. The contractor had built the cofferdam the same size as the concrete lines of the footing, and in not driving the sheeting far enough below the footing elevation to get a foothold, a great deal of trouble was experienced in keeping the sheeting from bowing in at the bottom. This naturally caused a great deal of water to come into the hole; the bottom seepage also was considerable. After a great deal of grief along the above mentioned lines, the first concrete was finally poured January 31, 1921, with a bottom dump bucket.

In the meantime, the contractor assembled a 40-ton steam derrick at the site of the west abutment, designated "G," and started excavating about October 25, 1920. He used 10ft. Wakefield sheeting, and experienec no trouble in unwatering this hole with a 7-in. Nye pump. The subsoil encountered was a very good grade of gravel in the front half of the abutment and a poor grade in the rear half. To overcome this, 13 additional foundation piling were driven, making a total of 104, aggregating 1,746 lin. ft. The first concrete was poured with a tremie, at a great cost to the contractor, about January 10, 1921.

The steel derrick was then moved east to the last pier, designated "F." The contractor again used 20-ft. Wakefield sheeting in this hole, and attempted to carry down the excavation as the sheeting was driven and cofferdam frame settled; that is, a few feet at a time. A sandy clay was encountered from natural ground elevation, about 498.00 to elevation 478.00; below this an excellent cemented gravel was found and grade was established at elevation 477.30. The plans showed the foundation at elevation 484.00, but on account of the poor subsoil it had to be carried to the elevation mentioned. A total number of 117 foundation piling, aggregating 1,872.5 lin. ft., were driven through the water. When the hole was then unwatered, it was found that sheeting was badly bowed in on the southeast and southwest corners, but not enough to warrant rejection of the hole. This cofferdam was also built to the exact concrete lines. The first concrete was poured about April 15, 1921, and no further trouble was experienced to build up the shaft of the pier.

During the late fall of 1920, the contractor built a barge 22x52 ft. for use in handling the river piers, and equipped it with a new three-drum American hoist. This piece of equipment was not able to do much good until after the spring floods, except for light work around the extreme east pier, designated "B." However, in May, 1921, pier "C," numbered from the east end of the structure, was finally started again. The contractor had open dredged this hole about three times, and every time he was all prepared to place the cofferdam there was a small rise in the river, and the hole would completely fill up with silt and sand. The same procedure was followed in sinking this hole as in the previous ones. A total of 118 foundation piling aggregating 2,083.75 lin. ft. were driven through the water. When the electric pump was set up and the hole unwatered, it was found that the bottom of the Wakefield sheeting was bowed in an average of 2 ft. in the south half of the cofferdam. The hole was therefore rejected. Part of this situation was due to the fact that the contractor had driven eight round piling in the southwest corner to stop a leak through the sheeting. Another reason, and the more important one, was that

the bottom set of rangers was kept about 6 ft. above grade, and the fact that the sheeting did not have more than a 6-in. toehold in the gravel gave nothing to take the pressure. The cofferdam, too, had been built to the exact lines of the footing concrete.

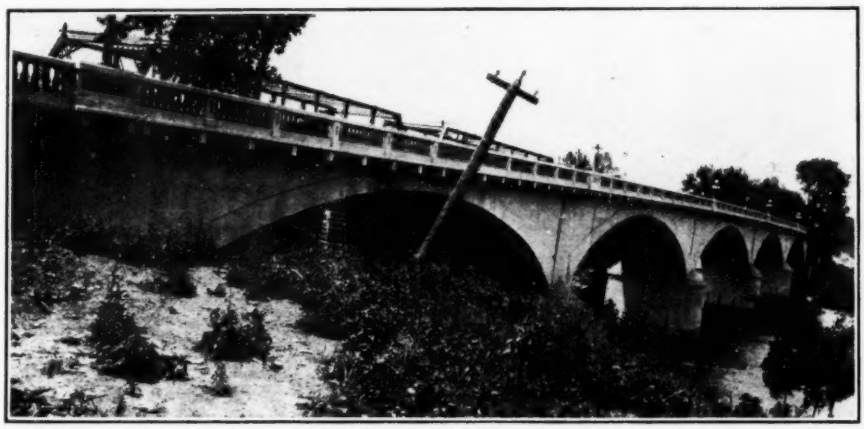
At the suggestion of the State Engineers, the contractor drove 22-ft. steel sheeting around the south half of the cofferdam on the outside of the Wakefield sheeting, and then the latter were cut off below the bottom ranger. No further trouble was experienced and concrete was poured with a bottom dump bucket.

In the meantime, the steel derrick was moved to the foundation designated, Pier "E" at the west edge of the river. Twenty-foot Wakefield sheeting was used and driven only 4 or 5 ft. ahead of the excavation and the cofferdam was settled as the latter proceeded. The hole was kept unwatered at all times and the results proved gratifying. The final cofferdam and sheeting were in excellent shape, practically no leakage through the sides at all. An excellent subsoil of cemented gravel was obtained. A total of 117 foundation piling, aggregating 1,879.2 lin. ft., were driven and completed July 2, 1921. The hole was kept unwatered when footing concrete was poured a few days later. An interesting feature of the driving of the Wakefield sheeting in this hole was the use of a so-called Jonathan pole to guide the steam hammer. In this particular location it permitted speed, together with careful workmanship.

After the barge completed Pier "C," it was moved to the next foundation west, designated "D," the last one to be completed. The same procedure of open dredging was followed, but the cofferdam was made about 6 ins. larger than the footings, and also 22-ft. steel sheet piling was used. This hole was sunk in record time without any difficulty whatever. An excellent subsoil of hard cemented gravel was encountered. The first concrete was poured in August, 1921, with a bottom dump bucket.

Observations of Foundation Work

The footing conditions encountered were ideal in more ways than one; in practically every case an excellent gravel subsoil was encountered capable of safely holding up at least 5 to 6 tons per square foot, and the piling also were driven in excellent shape, but somewhat harder than was necessary. It was desired to have at least a 20-ton safe bearing capacity; however, it is the writer's opinion that the average is near 25. This was increased so as to be absolutely sure at all times that every pile would safely carry 20 tons. Due to the fact that most of the piling were driven through about 12 ft. of water by means of a follower, it was more or less necessary to make the thing fool-proof. Even though a cast iron cap was used, it was impossible to keep this follower in good shape because of the enormous amount of punishment it received. From a study made before and after the follower was put on the pile, it appeared that at least 20 per cent of the force of the blow was taken by it. Most of this was due to broomed ends, but a good deal was also due to the fact that the stick was not entirely rigid, that is, it had some play, and also because it could not be kept vertical.



VIEW OF SIX SPAN REINFORCED CONCRETE HIGHWAY BRIDGE OVER WABASH RIVER AT ATTICA, IND.

After the piling were all driven and the holes unwatered, it was found that the original locations had been kept very well and most of the piling were driven just about as indicated on the plan. It was found, however, that driving through water is a task that gives deceiving results and therefore requires a good deal of attention.

Piers

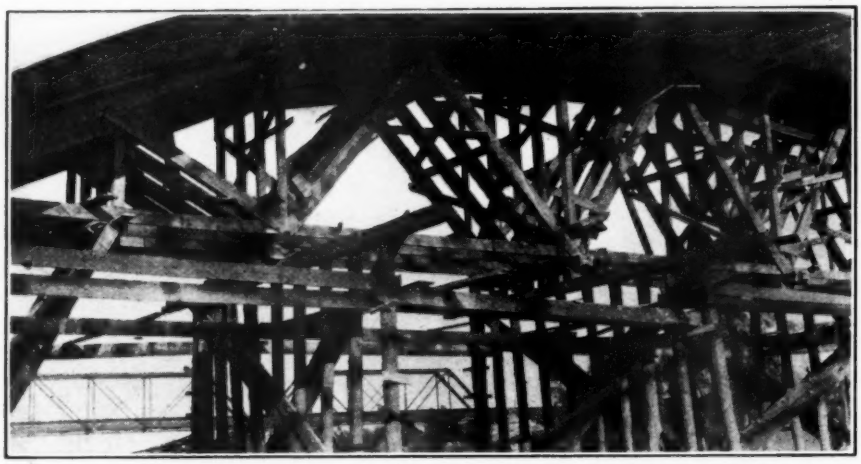
After foundations were poured, the forms for the shafts of the piers were built to the bottom of the coping, approximately 19 ft. 10 ins., and the concrete poured. After this, the coping, umbrella tops, skewbacks and 1-ft. spandrel were poured in one operation. Sufficient keyways and horizontal surfaces were left on the top of the skewbacks in the counterfort locations, and this was also finished on top to give drainage to the intakes of three 4-in. cast-iron pipes that discharge into the river on the sides of the pier. It was found to be a very difficult task to build the umbrella tops to the correct lines and grades; therefore, after three complete caps had been poured with nongratifying results, it was decided to get the centering adjacent to the piers in position first, and then it became a more easy matter to build the forms and hold them.

Arches

Before all of the foundation work was complete, the contractor had started the driving of the false-work piling for the arch centering. Those on the east side of the river were driven with a mule traveler, the barge drove those in the river and the steel derrick those on the west bank. The centering for one-half of each arch was laid out in the yard, marked and cut, and, therefore, was in good shape to put into position. This centering was designed so that it would not act as a truss, but, instead, to transmit the load directly to each pile bent, which was at about 22-ft. center.

It was decided to pour the south half of the arches first, thus putting in a longitudinal construction joint through the center line of the bridge. In addition to the great amount of transverse reinforcing steel, a large number of keyways were put in on the vertical surface of the joint, which assured that the two completed halves would act as a unit.

The first two halves on the east side were first poured, the last two on the west end next, and the two intermediate followed soon after. It was found that there was some settlement, the maximum being about 2 ins. in each case. Some of this was due to the joints of the centering tightening up and more of it to the settlement of the piling.



CONSTRUCTION VIEW OF ATTICA BRIDGE SHOWING ARCH CENTERING.

A longitudinal keyway, 4 ins. wide and 3 ins. deep, was put in the extrados of the arches, flush with the inside of the spandrel walls, and sufficient keyways were placed in the base of the counterforts to take the shear caused by the thrust of the earth fill against the spandrel walls. In each case, that part of the curb and gutter and the few cantilevered brackets over the crowns of the arches were poured the day following the pouring of the arches, so as to insure a bond between the two pours. The intermediate 12-in. spandrel walls, including curb and

gutter and cantilevered brackets were poured later.

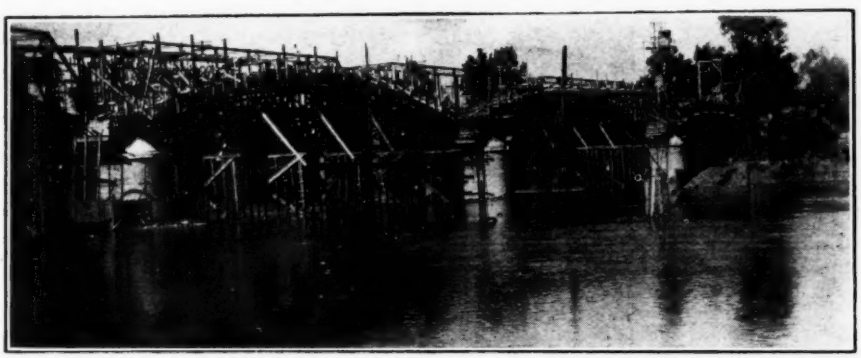
An expansion joint filled with a ¼-in. tarred felt was put in between spandrel walls over the arches and those over the piers; a construction joint was put in between the outer edge of 8-in. curb and sidewalk, and the top of every second cantilevered bracket at the point where the sidewalk joints were made, was painted with a water proofing compound. This was all done to permit proper expansion and contraction due to the rise and fall of the arches.

After the south half of the arches were poured, the question of proper lowering of the centering came up, and it was decided that due to the fact that the entire structure acted as a unit, it would be folly to attempt to release the centering of one arch until the other ones were ready to take their share of the load. The contractor, therefore, was permitted to strike the centering of an arch 30 days after it was poured, provided the adjacent one had been poured 30 days, the second one two weeks and the rest at least one week. This procedure was then carried out.

The lowering was done by means of 12-in. hardwood wedges that had been placed under the centering on the top of the pile caps. In some cases, the center wedges were lowered first and the work proceeded towards the two ends; in others, it was done from the ends towards the middle. No advantage was discovered in the use of either method; however, the greatest care was taken at all times to lower the entire centering gradually. The wedges under several arches were found to be very tight, due to contraction of arches caused by cooler weather.

It was the contractor's plan to re-use this centering as a unit for the north half of the structure. It was therefore built very substantial and solid, and no trouble was experienced in dragging it into position. This was done by placing 4-in. rollers under each panel on the top of the pile caps, and then pulled into position by means of three crabs fastened to the ends and centers. Great care was exercised to see that entire centering was moved evenly and at the same rate of speed. It was then jacked up and wedges placed underneath. The lagging was permitted to extend 2 ft. beyond the construction joint at the center line of bridge and then jacked up as tight as possible against the intrados of the arch. The outer end then was brought up about ¾ in. above this elevation. This was done to take care of uneven settlement caused by the fact that the end was not jacked up as tightly as the part next to the arch already poured.

It is interesting to note that the final joint between the two halves came out even, which indicates that there was little settlement. It was thought that the use of the centering the first time would tend to compress the timber and bring the joints up so tight that there would be no give at all the second time, so this proved to be about the case.



CENTERING IN POSITION TO POUR NORTH HALF OF ARCH, SPAN NO. 4, ATTICA, IND., HIGHWAY BRIDGE.

The same procedure was followed on all of the arches, and at no time was there any hint of grief in re-using the centering as described.

Concrete Plant

On account of contemplation of winter construction, it was decided to store a sufficient amount of the aggregate to last during the winter months when the local gravel plants suspend operations. The plant mix aggregate was bought from the Carmichael Gravel Co. and the Neal

Gravel Co. located two and three miles, respectively, south of Attica on the Covington-Attica branch of the Wabash railroad. The material was shipped to Attica at the rate of six cars per day, and spotted on the track nearest to the bridge site at a distance of 1½ blocks from the east end of the existing and proposed structures, at the point where it was decided to build the stock pile. The material was hauled to the stock pile in bottom-dump wagons. By means of a snatch team and a careful sloping of the approach, the pile was carried to a height of 20 ft. At the time the pits ceased operations on Dec. 21, 1920, about 110 cars of aggregate had been delivered.

The concrete mixing plant was arranged to take advantage of the natural conveniences. A 250-cu. yd. capacity bin was built under the approach span of the old structure. Three openings were made in the floor of the north side of the span and were so arranged that the traffic could safely pass over them when they were closed. The doors were made of a ¾-in. iron plate, to which was bolted a plank flooring. These horizontal plates ran over short sections of gas pipe placed on 4-in. centers, and it therefore required very little effort to manipulate them.

The material was reloaded from the stock pile into bottom dump wagons by means of an "A"-frame traveler with a 60-ft. boom, equipped with a ¾-yd. clamshell. It was dumped directly from the wagons into the bin through the openings in the floor of the old bridge. The sloping floor of the bin was built with a false bottom through which steam coils passed, beginning at the top and running longitudinally back and forth to the bottom, where a valve was placed for drainage purposes.

In cold weather, the steam was turned on the evening before concrete was to be poured, and by morning the material was very hot, decreasing in temperature toward the top of the bin away from the coil.

It was found necessary to keep several men in the bin to keep the coarser material from separating from the finer, and thus the entire mass was thoroughly intermixed and it was possible to keep the concrete at an average temperature of about 70 degrees. The moisture found its way to the bottom of the bin and seeped away.

CONCRETE PLACING PLANT ON ATTICA BRIDGE CONSTRUCTION.

In the spring of 1921, this entire bin collapsed, and for the remainder of concreting, aggregate was simply dropped under this approach span as it was delivered and worked to the opening and the mixer by hand.

The aggregate passed through a vertical sliding gate into the measuring hopper. Two compartments, each containing the proper amount of cement for the particular class of concrete to be placed were built above and to the side of the measuring hopper, and by means of vertical sliding doors the contents of either compartment were discharged on the top of the gravel. From the mixer, the concrete passed directly into a bucket on an 80-ft. tower, from where it was distributed to different points as described later.

In the summer of 1921, the contractor built another concrete plant at the west end of the old structure. The aggregate was dumped through the floor of the old

bridge and carried to the mixer by a wheelbarrow gang. A 60-ft steel tower was used to chute the concrete to the forms.

Method of Transporting and Placing Concrete

The foundations and parts of the shafts of the piers were all poured from the old structure. Trucks, with a hopper built on the frame, were loaded under the chute at the east end of the old structure and transported the concrete where needed, and it was then carried to its permanent position by means of chutes from the old structure. Later on, after the south half of the extreme east span was completely poured (including arch, spandrel walls and sidewalls), a narrow gauge track was laid directly over the wall. The concrete was then dumped from the tower into a hopper directly over the track from where it was loaded into side dump cars and hauled with a dinky gasoline locomotive. A temporary track was laid over the arch ahead to be poured and the concrete was deposited by means of chutes. As soon as the span was entirely completed the track was laid as on the first one. In this way the work progressed through the third arch. The last three had in the meantime been poured from the mixing plant on the west side of the river. In cases where the concrete could not be handled with a chute, it was brought to a centrally located hopper and carried into position by means of buggies on a temporary platform built over the arch. The narrow gauge track was built clear across the bridge as soon as the spandrel walls were complete, and was utilized to transport all of the concrete for the south half of the structure.

Backfilling Over Spans and Building Approaches

After the steel derrick completed its part of the foundation work it was moved to the west near the extreme west abutment and started backfilling around the abutment and also the west approach taking material from a borrow pit on the upstream side of the new bridge. About 6,000 cu. yds. of material were obtained in this way. This borrow pit had been donated by the local merchants in order to get away from using any part of the old fill for the new one, and thereby at some time or other shutting off the traffic into town from the west.

An additional 6,000 cu. yds. were required to complete the west approach, about 5,200 over the bridge proper and about 700 in the east approach. The contractor decided to use the gravel in the river, and permission was given him to do so. He was then asked to fill in over the arches in such a way that the load would be evenly distributed along the entire length of the bridge.

A mule traveler was set up over the pier at the west edge of the water, and it dipped the gravel out of the river from the north side of the bridge and loaded the hopper cars, which were then hauled away with the dinky locomotive. The barge in the meantime relayed the material from farther up stream to a point where the mule traveler could reach it. The material was a well graded gravel containing about 30 or 40 percent sand, and was well suited for this purpose.

In this manner the filling was brought up in successive layers along the entire length of the bridge, and the approaches were also completed. However, the mule traveler had to be moved to the next pier east on account of the fact that the gravel was becoming unavailable in this location. The barge had to relay the material about three times, and then, even working 24 hours per day, could not keep up. On account of possible danger to the permanent structure, the contractor was not permitted to remove the material below the bottom footing course, 4 ft. above grade.

The mass of the filling was done during the winter months of 1921-1922, and most of the material froze when it was deposited. No ill effects of this were ever noticed, however, due to the fact that this was not all completed until warm weather set in, which gave the contractor an opportunity to take care of all of the settlement when the frost came out.

On account of the new approach covering part of the old one, it became necessary to shut off traffic for three days while this part of the fill was being completed. Traffic was finally permitted to cross March 9, 1922. Some little doubt was experienced about the possibility of this clean washed gravel packing, but after two weeks it became evident that the fears were groundless. A test made four weeks later showed that gravel was packed so hard for a depth of 8 ins. that it was impervious to water. Part of the success in maintaining traffic was due to the fact that a 4-wheel drive Nash truck was first taken across and made a two-way traffic path, and subsequent vehicles followed these same ruts and gradually packed the roadway.

Organizations

The work was done under the super-

vision of William J. Titus, bridge engineer for the Indiana State Highway Commission. H. A. Hanapel was resident engineer. Standish & Allen, of Chicago, were the contractors. Mr. A. Cross, of Columbus, Ohio, was in charge as general foreman the last year the work was in progress. Mr. S. Standish was the engineer in charge for the contractor, and later was made superintendent.

DESIGNING CONCRETE SHORE WALLS

By A. W. Consoer, Consoer Engineering Co., Consulting Engineers, Marquette Bldg., Chicago, Ill.

A problem that is often presented to municipal engineers is the construction of a concrete wall as a protection to the shore of a lake or river. Such walls are commonly referred to as sea-walls, although that term is a misnomer when applied to a wall to be built midway between the Atlantic and the Pacific.

The writer has examined a great many walls of this kind in front of properties on the inland lakes of northeastern Illinois, and has found many of them in bad condition. In the Spring when the ice goes out with the high water, accompanied sometimes by strong winds, walls that have not been properly constructed fail to withstand the destructive effects of wind, ice, and water, and are ground up into fragments of concrete.

A frequent cause of the failure of a concrete shore wall is a foundation that is not carried deep enough to insure the stability of the structure. In the writer's practice it has been found that foundations which do not rest on rock should be carried at least 4 ft. below the adjoining lake or river bottom. Where there is danger of undermining, the foundation should be carried even deeper or should rest on timber piles. Where the footings rest on a stiff clay, hardpan, or cemented gravel, no piles will be needed ordinarily if the foundations are carried 4 or 5 ft. below lake bottom. Wet sand, however, flows unless confined in some way, and may be subject to undermining. Holes 5 to 10 ft. deep in sandy river bottoms, due to local "scour," are not at all uncommon, and where such a sandy subsoil or other soft foundation material is found, the desirability of using a pile foundation should be considered. Wave action on inland lakes may undermine walls built on sand without piling. If a good subsoil is not found 4 ft. below lake bottom, it is sometimes cheaper to go 2 or 3 ft. deeper rather than to drive piles. In such cases hard bottom can be tested for by thrusting down a reinforcing rod or preferably by sinking test holes. In the case of walls built on solid rock it is advisable to blast out a trench about 12 ins. wide and 12 ins. deep, in order to key the wall into the rock.

The solid concrete wall is used more frequently than a reinforced concrete wall, although the latter type is often more economical. A solid wall must be so proportioned that the resultant of all forces acting on the wall, including the weight of the concrete, the pressure from water, waves, ice, and wind, and the earth pressure of the backfill will fall within the middle third of the base. The wall must be designed to resist crushing at the outer edges, and the safe bearing value of the subsoil must not be exceeded. The wall must also be safe against sliding along a horizontal joint or on the foundation, and safe against shearing along any section, but in the case of a concrete wall this is a very improbable cause of failure. It is not a difficult problem in structural engineering to determine the proper dimensions for such a wall under any given conditions, but unfortunately most of the walls that have been observed by the writer have not been designed at all, and illustrate the importance of constructing such walls in accordance with the principles of masonry design. It has been the writer's observation that more shore walls fail or show signs of poor construction than stand up as they should. This is due usually to shallow foundations, but often to scanty design. Before undertaking the construction of a shore wall, the contractor should protect his own interests and those of the owner by insisting that the wall be designed by a structural engineer, or else make his own design in accordance with the principles given above. In several states the law requires that structures of this kind be designed only by licensed engineers.

A transverse contraction joint should be provided at intervals along the length of the shore wall. The joints may be placed about 25 ft. apart and should be of the tongue and groove type. Where it is necessary during construction to leave a horizontal joint in one of these 25-ft. sections, a timber 12 ins. wide and 6 ins. thick should be laid the entire length of the course and imbedded in the concrete, and removed only after the concrete has set. The surface of the joint should then be cleaned and painted with

a thin mortar before concreting is resumed. This type of horizontal joint is needed particularly where there is likelihood of ice flows. In certain cases it is advisable to strengthen a horizontal joint of this kind by inserting dowel bars. This is frequently done when the footing is built first and the balance of the wall later, in order to make the junction between the wall and footing secure against a failure by sliding.

A shore wall must withstand some very definite forces and must be of the best construction to resist their destructive effects. In general the quality of the construction should be the same as that required for first class reinforced concrete bridge work.

NEW ROAD OIL SPECIFICATIONS FOR ILLINOIS

By H. F. Clemmer, Engineer of Tests, Illinois Highway Division, State House, Springfield, Ill.

The ever increasing use of road oils in the State of Illinois has prompted a considerable amount of laboratory investigation and practical research, and results of which have done much to enable the highway department to prepare its new set of road oil specifications. As a great many factors have bearing upon the satisfactory use of these oils, specifications covering the quality of the material have in the past been only a means of rejecting the poorest of grades. The present specifications are expected to do considerable in bringing about the oiling of roads to a better advantage insofar as economy and service are concerned.

Extent and Cost of Road Oiling in Illinois in 1921

The oiling of roads in this state has passed the embryonic stage where the expense and results are not to be considered. In 1921 there were 7,000 miles of roads oiled in Illinois at a total cost of approximately $1,500,000. Over 25,000,000 gals. of road oil were used in this work. The cost of this material amounted to about 5 cents per gallon delivered, with the cost of application amounting to 1 cent per gallon. The average cost of oiling a mile of road in 1921 ran between $200 and $250.

Increasing Public Interest in Oiled Roads

Increasing public interest in oiled roads has created a demand for more information relative to the best methods of applying oil, the comparative merits of different kinds of oil, and the types of oil to be used on various kinds of soils. The great lack of uniformity in applying oil to roads has been the subject of considerable discussion for some time, and investigations in this as well as other problems relating to the use of oil are wanted. The Illinois Highway Division has recognized this want and has made considerable progress in the investigational field. A far greater number of experiments are now being planned and will be executed within a short time. The University of Illinois has also come to the same conclusions and consequently is planning extensive investigations in road oils. Under the direction of the Engineering Experiment Station a 12-mile experimental road has been provided upon which various problems attending the oiling of roads will be taken up.

Trend in Illinois Is Toward Heavier Oils

During the past few years, the laboratory of the Division of Highways has tested several thousand samples of road oil and has collected much valuable information regarding the quality of oils from various sources, and results obtained from their use under various conditions existing in Illinois. The activities of the laboratory through its testing and work in preparing specifications has had the result of gradually improving, both in respect to uniformity and quality, the oils which are being used in this state. The most noteworthy feature of present road oil practice in Illinois is the tendency toward the use of heavier oils. A few years ago practically all oil used contained between 40 and 50 percent asphaltum, heavy oils being considered unsafe or unsatisfactory to use. Figures compiled by the laboratory show that during 1921 70 percent of all oil used in the state was purchased to contain 50 to 60 percent asphaltum, 16.5 percent to contain more than 60 percent asphaltum, and only 13 percent to contain less than 50 percent. Recognizing this condition, the laboratory has prepared the following specifications, and it is probable that practically all oil purchased in the state during this season will be purchased under these or very similar specifications.

Specifications for Oil for Earth Roads

Specifications E-1

(These specifications admit Mexican and similar asphaltic base petroleum residuums. Semi-asphaltic base petroleum when refined by certain processes may yield residuums meeting with these specifications.)

1. The road oil shall be homogeneous and free from water. It shall meet the following requirements:

2. Specific gravity 25°/25° C. (77°/77° F.), not less than 0.930.

3. Specific viscosity at 40° C. (104° F.), 25.0 to 75.0.

4. Loss at 163° C. (325° F.), 5 hours, not more than 25.0 percent.

5. Total bitumen, not less than 99.5 percent.

6. Percent of total bitumen insoluble in 86° B. naphtha, 7.0 to 18.0.

7. Flash point, not less than 80° C. (170° F.).

8. Percent of residue at 100 penetration, 50 to 60.

Specifications E-2

(These specifications admit petroleum residuums refined from petroleum from Texas, Louisiana ,Oklahoma, Kansas, Illinois and other semi-asphaltic petroleums. Oils meeting the requirements of Specifications E-1 will be acceptable under Specifications E-2.)

1. The road oil shall be homogeneous and free from water. It shall meet the following requirements:

2. Specific gravity at 25°/25° C. (77°/77° F.), not less than 0.900.

3. Specific viscosity at 40° C. (104° F.), 25.0 to 75.0.

4. Total bitumen (solubility in carbon disulphide), not less than 99.5 percent.

5. Percent of residue at 100 penetration, 50 to 60.

6. Flash point, not less than 80° C. (175° F.).

Specifications E-3

(These specifications admit either asphaltic base or semi-asphaltic base petroleum residuums of a heavier grade than covered by Specifications E-1 and E-2.)

1. The road oil shall be homogeneous and free from water. It shall conform to the following requirements:

2. Specific gravity at 25°/25° C. (77°/77° F.), not less than 0.930.

3. Specific viscosity at 100° C. (212° F.), 2.0 to 6.0.

4. Total bitumen, not less than 99.5 percent.

5. Percent of residue at 100 penetration, 60 to 70.

Tests of the physical and chemical properties of the road oil shall be made in accordance with the following methods:

1. Specific gravity—U. S. Dept. of Agriculture, Bulletin 949, Test No. 19, p. 36.

2. Specific viscosity—U. S. Dept. of Agriculture, Bulletin 949, Test No. 27, p. 44.

3. Loss on heating—A. S. T. M. Standards, 1921, Serial Designation D6-20, p. 731.

4. Total bitumen (solubility in carbon disulphide)—U. S. Dept. of Agriculture, Bulletin 949, Test No. 20, p. 38.

5. Naphtha solubility—U. S. Dept. of Agriculture, Bulletin 949, Test No. 22, p. 40.

6. Flash point—U. S. Dept. of Agriculture, Bulletin 949, Test No. 24, p. 42.

7. Percentage of solid residue of 100 penetration—U. S. Dept. of Agriculture, Bulletin 949, Test No. 28, p. 45.

Specifications E-1 and E-2 may be considered as alternate specifications covering oil for cold application or which would require only slight heating. Specifications E-3 admit oil of a somewhat heavier grade than covered by the E-1 and E-2 specifications. This grade is best suited for hot application on soils of a somewhat sandy nature or on roads which have been previously treated with a lighter oil.

PLANT INSPECTION NECESSARY TO INSURE GOOD BITUMINOUS PAVEMENTS

By Francis P. Smith, Consulting Paving Engineer, 131 East 23rd St., New York, N. Y.

I think it is a fair statement to make that any one who has thought of this subject, and is familiar with the various processes of construction, regards it as an axiom that plant inspection *is* a necessity to insure good bituminous pavements. It is a fact, however, that in all highway organizations there are a number of officials and engineers who have not made a special study of bituminous construction. An engineer in a great many cases is regarded as a high light, as a sort of tin god, by his constituents and is supposed to be a jack of all trades—and has to be in order to hold his position—and the multiplicity of his duties leaves him but little time to specialize in any one direction.

The Temptation to Neglect Plant Inspection

Let us assume, for the minute, that we are in the position of an engineer who has not specialized in bituminous construction. Certain contracts have been let in his district for asphalt pavements. His appropriation is more or less limited and perhaps he is doubtful as to the real necessity for plant inspection. After the foundation has been laid and is ready for the bituminous top, he visits the plant. He finds it in operation apparently running all right, the batches being turned out and the sand assembled and fed to the dryers and the trucks are

leaving with fair regularity and the mixture looks all right. It is black and the sand seems to be fairly well coated. He takes a sample from the load and tests the temperature and finds it comes within the limits of the specification requirements. From there he goes to the road, where he finds the trucks delivering the hot asphaltic mixture. It is being shoveled, spread and rolled in good workmanlike manner and he comes back to his office and thinks: "What real necessity is there for an inspector at the plant? Everything seems to be going all right, and why visit the plant more than once a day and the street occasionally? Why is not that sufficient?" He lets it go at that, and if he is fortunate enough to get a good pavement he is likely to come to the conclusion that plant inspection is not a necessity but a more or less expensive luxury which can be omitted when appropriations are scanty. There is another side to the question, however, and as I firmly believe that it is true that we learn more from our own failures and mistakes than from any other source, I am going to cite certain failures which were wholly due to inadequate inspection as possibly the best way of emphasizing the point which I am here to make.

Lessons from Three Failures

Fortunately for my illustration, within the last three years three failures of bituminous pavement have come to my attention. In all of these cases it happened that I was entirely familiar with the circumstances attending their construction and the kind of materials used and the personnel of the contractor and the engineers under whose direction these pavements were laid.

In Case I the engineer decided to limit his inspection to daily visits to the plant and street, supplemented by a daily analysis of a sample taken when he visited the street. Instead of a complete analysis he determined the bitumen content only, on the theory that the amount of asphalt that went into a bituminous road was one of the most important elements to check up, and that as the asphalt was the most expensive ingredient of the pavement he would be more likely to find a shortage there than in any other constituent. In this instance he was drawing on his experience in concrete construction work.

In Case II the engineer decided against complete inspection, but he or one of his assistants took a daily sample of the mixture and had a complete analysis made of it.

In Case III the engineer was convinced of the necessity of plant inspection and assigned a good inspector to cover the plant and had daily complete analyses made of the mixture, but he thought the street gang could get along all right. This case is perhaps outside the limits of my subject but seems to me of sufficient importance to warrant the liberty of including it.

In Case I a single sand was used and this sand had been examined carefully and approved as suitable for the construction of a sheet asphalt pavement. In Case II two approved sands were used and they were supposedly mixed in the proportions designated by the engineer. In Case III only one sand was used and there was practically no street inspection and the street gang was composed of unskilled and incompetent men. Still keeping the preliminary conditions in mind, let us inspect these roads after they have been completed and subjected to traffic for various periods of time.

The First Case

In the case of the first road, the time will be four months. We find a small portion of it in excellent condition, a part of the remaining portion is scaling badly, and the balance of the pavement is both wavy and scaly. Remember, please, that this is only four months from the day this pavement was laid. This is no theoretical case.

Now, what really happened was this: An examination of the pavement from the different portions of the street showed very clearly that the portions of the pavement which were in fairly good condition carried about the normal percentage of bituminous material. The portions of the pavement that were scaling, instead of carrying between 10.5% and 11.5% bitumen, carried on the average only 8.5%. The portion which was "shoving" had about 9% of bitumen. The analyses made by the engineer of this pavement all showed a bitumen content running between 10% and 11% and, as you will recall, these samples were taken by the engineer on his daily visits to the street.

It developed on further investigation that owing to the pressure of other work, the engineer regularly paid a visit to the street between 10 and 11 every morning. Therefore, the men at the plant and the men on the street, after that visit between 10 and 11, knew there would be no further visits made that day, and no other samples would be taken for analysis. It was very easy, therefore, for them to run during the early portion of the day a mixture which contained the normal per-

centage of bitumen regardless of what they did afterward.

It was also the case in this particular pavement that the contractor to whom the job was awarded was a man who had had a good deal of experience in public work, a man who stood very well with the administration, but this was his first attempt to lay a bituminous pavement. He was brought up in a school where anything to increase the output of the work could very often be gotten away with and such methods often did not seriously damage the final result, and being ignorant, he had to rely on the advice of the men he had hired for the job on the street and at the plant. They tried to make a low cost record for themselves by saving asphalt when they thought it would not be detected and by speeding up the plant.

The deficiency in bitumen was one of the causes for the failure. Another cause was the fact that the pavement was insufficiently compressed, the rolling was done superficially, and the finished pavement had a density of between 1.85 and 1.89, which is much too low. An examination of certain portions of the pavement which were defective showed that not only was the bitumen content low, but the grains of sand were insufficiently coated. That led to an investigation of the record as to the daily output of the plant.

The plant had an ordinary 9-cu. yd. mixer which turned out a batch of 1,000 lbs. of material. The specifications, backed up by the requirements of good practice, called for at least one minute's mixing in the mixer, the revolutions of the shafts between 60 and 80 per minute. An experienced mixing crew, trained to the last minute and entirely competent, can probably turn out one batch of mixture every minute and 20 seconds and give a full minute's mixing to each batch. An exceptionally well-trained crew can, throughout the day, average one batch in 1 minute and 30 seconds. Giving the contractor the benefit of the doubt and assuming his crew to be an exceptional one, that would make 40 batches an hour. A thousand-pound batch will lay 5 sq. yds. of 2-in. pavement, so the maximum output which could be allowed to a contractor doing his work properly and giving it the required time of mixing, would be 200 sq. yds. per hour. In this particular case the work was prosecuted with a 9-hour plant day. That gives us 1,800 sq. yds. per day as the maximum output for that plant. We found on investigating the records that 2,500 or 2,800, and even as high as 3,000 sq. yds. had been laid per day, which meant that the mixing was cut fully in half. That accounted for the insufficient coating of the sand grains. That, combined with the lack of rolling and the low percentage of bitumen, accounted entirely and wholly for the failure of that pavement in four months.

The traffic on that road was heavy. The foundation was of concrete 8 ins. thick and the subsoil was properly drained. There was no question of improper foundation or improper drainage. Further investigations involving a pretty close approximation of the daily amounts laid and their relative service records after the four months showed, in those cases where it was possible to trace them, which was about 30% of the time, that the pavement laid in the period from early morning up to 11 o'clock have given very good satisfaction. That illustrates as plainly as words can tell, what took place after the engineer had paid his daily visit and the contractor felt himself free from further supervision for the balance of the day.

An inspector at the plant would have verified the weights of the mixture. He would have verified the time allotted to mixing. He would not have permitted them to reduce it and the mixture sent to the street would have been of uniform bitumen content and his temperatures would have been properly maintained. The cost of that inspector at the plant, weighed against the indirect cost to the city through the inconvenience to the public while taking up and replacing that pavement, and the cost of a new pavement which will fall directly on the contractor, would have paid for ten inspectors at the plant ten times over.

The Second Case

Now let us visit the second road. In this road two sands were used: one a coarse sand, and one a fine sand. In the fine sand the particles were almost wholly composed of quartz. They were very sharp and had rough surfaces to which bitumen adhered well. The coarse sand was partly rounded, and if used by itself would not have made a stable mixture. It was, however, the only coarse sand available in that location at anything like a reasonable cost and not more than 33% of it was required in the mixture. A mixture made according to these proportions would have had sufficient stability and was in all respects an excellent mixture.

In this case you will remember daily samples were taken by the engineer on the street and the analysis that was made

involved only the bitumen content. The contractor was a man who had had very considerable experience in the laying of sheet asphalt, a man of high business honor and integrity and he tried honestly to lay the best pavement he knew how. The plant foreman was very good in some respects but slack in one particular. That one particular was fatal. Two years after that street was laid, possibly one-half of the pavement was in good condition and the balance was waving badly.

The cause for the defective portions of the pavement was clearly traced to lack of care in the mixing of the sands. The established proportion for the sands was 2 of fine to 1 of coarse. Now, if you have had experience with asphalt plants, especially at the start of a piece of work, you will realize how very difficult it is to get men to keep their coarse sand piles separate from the fine sand piles and establish a system whereby the sands will be mixed in the right proportion. In this particular case the coarse sand was very much cheaper than the fine. The plant foreman, thinking to do his employer a good turn and reduce the cost to him of the pavement he was laying, tried to use all the coarse sand possible. That policy was carried so far that possibly one-half of this pavement was laid with all coarse sand and no fine sand in it.

The analyses showed that the bitumen content of that pavement ran uniform. The men on the mixer did their duty, using the same amount of sand and the same amount of filler and they kept the mixture uniform in these respects and the engineer congratulated himself that this pavement was more uniform than the average and he expected the best results from it. When we have a pavement with a given bitumen content composed of a large aggregate we have one in which the surface is more thickly covered with bitumen than in a pavement of the same bitumen content which is composed of a fine aggregate. In this particular case, when using the coarse sand alone, the mixture containing 10.5% bitumen probably carried over 1% excess of bitumen, which was further aggravated by the fact that the rounded grains had a comparatively smooth surface. The result was a pavement which markedly lacked stability and under heavy traffic became wavy and shoved badly. In this case, the entire failure was due to improper mixing of the sands. An inspector at the plant who was competent and faithful would have kept an eye continually upon the men who were feeding the sand to the drum and would have seen that the coarse and fine sands were mixed in the proper proportion. Had he done so, that failure would not have occurred.

The Third Case

In the case of the third highway, which again was a main trunk line route, it also had a 6-in. concrete foundation and a subgrade more than ordinarily well drained, and only one sand was used. An inspector was present at the plant who was in every way competent. The analyses were complete and showed a mixture with a variation that was well within the average limits of departure from the standards set by the specification. In other words, the mixture was better than the average. The portions of the road that were laid in the early part of the season, showed at the end of two years a very decidedly wavy condition. Portions of the road which were laid toward the latter part of the season were as perfect at the end of two years, if not better than the day on which they were laid.

Here was a case where the mixture was not at fault, but what happened was this: In the early season the contractor had difficulty in getting a competent gang for the street. He had a poor roller man. He also had a four-mile haul from the plant and the men who shoveled the material after it was dumped from the wagon were untrained, and rakers and shovelers trampled upon the mixture while it was being spread. Complaint was made to the engineer having charge of the work of that very condition, but it appeared to be somewhat of a hardship to the contractor to expect him at the very start of the season to have a gang that was well trained and would fall into their places as they should. So, for a period of 30 days, workmanship on the street was tolerated which was not in accordance with the best practice but which would, possibly in 50 out of 100 cases, have resulted in an entirely satisfactory pavement. As is always the case, those portions of the street where the mixture had not been properly raked and fluffed up, contained places where the density of the pavement was greater than those parts immediately adjacent thereto, and when the roller passed over them, there was left a pavement which did not have the same density throughout. The compression exerted by a heavy truck is greatly in excess of that which can be obtained with a steam roller and the concentrated traffic on that particular road

found those spots that were less dense than others and began to depress them, and under modern motor traffic a depression once started quickly grows and gives rise to other depressions until a series of waves are formed, with disastrous results which are familiar to us all.

The three roads in question were paved with sheet asphalt with 1½ ins. of binder course and 1½ ins. of surface mixture. In a normal sheet asphalt mixture, a total variation of 1½ percent from the standard bitumen content desired is not necessarily fatal to the road or even extremely detrimental, so that with this type of pavement a certain amount of inaccuracy in weighing the ingredients can be tolerated without specially bad results, but in a great many sections of this country they lay what has been called Topeka mix, which is more or less of a hybrid. It was originally a sheet asphalt mixture containing a small percentage of stone. A great deal of this kind of pavement has been laid. Some of it has given very good results. In some cases its use has been justified by the fact that stone is cheaper than sand and the more stone, the cheaper the aggregate will be and the less will be the amount of bitumen required, and, therefore, a considerable reduction in the cost of the pavement will be effected. The limit of variation in bitumen contents permissible in a Topeka mixture is, however, very much smaller than that which is permissible in a sheet asphalt mixture; therefore, more careful watching is required on the part of the platform mixing gang and greater accuracy in the weighing of the asphalt and the other ingredients of the batch.

When you think of men in a cloud of dust that at times is almost unbreathable, turning out 40 batches an hour all day long, one wonders that they do as good work as they do, and it also becomes a matter of wonder how an engineer, having in charge a pavement involving 40 batches an hour separately weighed, could possibly go on without an adequate plant inspector and yet feel that the safety of the project was reasonably insured.

Temperature of Mixture

There is another point which I would like to discuss with you, which was not involved in the case of these three roads mentioned, in order to illustrate another vital reason why an inspector should always be present at the bituminous mixing plant, and that is, the question of temperature. A test of the temperature of the mixture as it leaves the plant or as it reaches the street is not sufficient. In making the mixture we have two elements which are heated, the mineral aggregate and the asphalt cement. If we overheat the mineral aggregate and have a cool asphalt cement we have in the finished product a mixture which will come within the requirements of temperature but we will have injured the mixture because the mineral particles carry only a very thin film of bitumen and if heated beyond the danger point this thin film of bitumen will harden very rapidly. If, on the other hand, the sand or stone has been saturated with moisture by heavy rains, the capacity of the drum for drying and heating the mineral aggregate will be reduced. Under such conditions, a foreman anxious to turn out a large output is tempted to overheat his asphalt to offset the low temperature of his heated aggregate, thus increasing the amount of mixture of normal temperature delivered by the plant. Such a mixture will be defective owing to undue hardening of the asphalt in the kettles and the bond between the bitumen and the sand will probably be weak.

In many cases, sand, which forms 75% or more of a sheet asphalt pavement, is obtained from large pits that are operated by experienced men and they deliver a uniform supply which requires very little inspection to insure the use of suitable sand in the mixture. In other cases, the contractor frequently opens up his own sand pit. Often times stripping is required and the face of the sand pit is found stratified, fine and coarse. Sometimes it is necessary to discard a layer 2 or possibly 3 ft. deep at the top in order to get a proper grading for the mineral aggregate. The contractor hires teamsters and places a man at the pit with a scraper and he instructs these teamsters to go to a certain portion of the pit and take the sand from there. The local teamster knows that the more loads he gets, the better he will be paid, and he takes the sand from the easiest or nearest part of the pit and the consequences are that half the loads should have been rejected. In other cases, where coarse and fine sand is mixed, it is very difficult to get the contractor to keep the sands separate. The drivers are careless and dump fine sand on the coarse pile and vice versa and there is no possible way of separating and grading the sands properly and the consequence is that the mineral aggregate varies so much that it does not come within the limit of the specifications or good practice, and, even if it

does happen to fall within those limits, the variation is still so great that in order to secure the best results, the bitumen content should be varied. This it is impossible to do satisfactorily.

The asphalt cement in former days used to be made at the plant by fluxing a hard asphalt with flux, but today most of the large asphalt manufacturers send tank cars that are tested, either before they leave the plant or on delivery, and the variations in penetration are very trifling and do not require to be tested more than once per tank car delivery instead of once for every kettle filled at the plant unless the contents of the kettles are kept under heat for a very long time.

The foregoing paper by Mr. Smith was presented at the Eighth Annual Conference on Highway Engineering at the University of Michigan.

OLD MACADAM BASE FOR ASPHALTIC CONCRETE PAVEMENTS

By W. F. Reichardt, Consulting Municipal Engineer, Watertown, Wis.

There always comes a time during the practice of an engineer when he is confronted with a proposition somewhat out of the ordinary that requires economic judgment, as well as engineering skill.

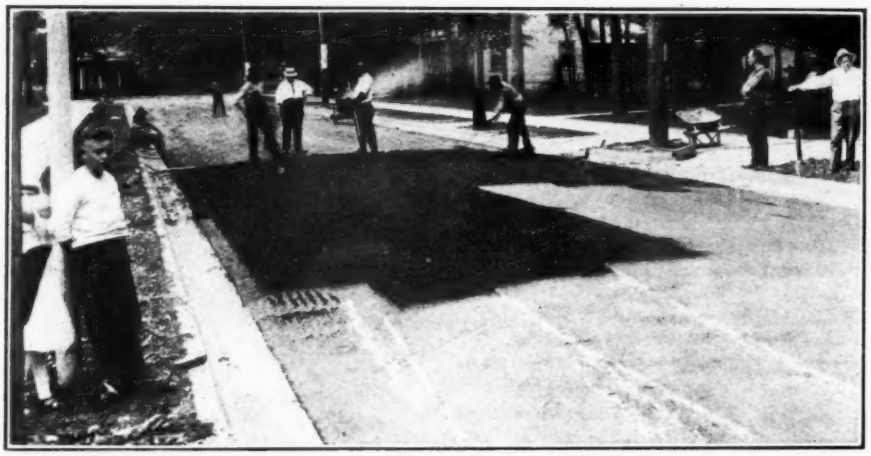
The writer was confronted with just such a proposition in 1921 when serving the City of Stevens Point, Wis., in the capacity of consulting engineer. That city, like many other cities throughout the country, had constructed many miles of macadam streets, which prior to the automobile and heavy truck was an economic proposition, but after the arrival of the automobile and heavy trucks these pavements required a heavy maintenance.

Stevens Point expended several thousands of dollars each year attempting to make these streets passable, but they were unable to do so successfully. At the request of the Mayor, Hon. J. N. Welsby, the writer studied the proposition confronting this city, with the idea of taking care of the traffic at a minimum expense. After a careful investigation it was found that the old macadam was thoroughly compacted after many years of service, and that its thickness was such as to afford an excellent base for some type of permanent wearing surface. The writer recommended that these five miles of worn macadam streets be covered with a 2-in. wearing surface of asphaltic concrete, thereby saving the city the expense of excavation for a concrete base added to the cost of the base itself.

The mayor, having confidence in the ability of the engineer, accepted the recommendation but the citizens somewhat doubted the feasibility of the proposition. It is this point that I wish to impress upon my readers, which is that the average citizen is not a judge of quality when it comes to the selection of pavements, but depends much upon their cost. The fact that I was offering an economic solution caused them to entertain doubts.

And in this position an engineer oftentimes finds himself: To carry out his idea, he must simply go before the people and fight for the acceptance of his recommendation. While it would have been more profitable to the engineer to increase the cost, it was his duty to show the citizens that they *must* accept his rec-

VIEW OF WATERBOUND MACADAM PAVEMENT IN STEVENS POINT, WIS., READY FOR RESURFACING WITH ASPHALTIC CONCRETE.



LAYING TEXACO ASPHALTIC CONCRETE ON OLD WATERBOUND MACADAM IN STEVENS POINT, WIS.

ommendation based upon years of experience.

After several mass meetings the property owners agreed to accept the recommendation even though they still retained some doubt as to its feasibility.

The writer prepared open specifications for an asphaltic concrete pavement, and advertised for bids extensively, and owing to the large contract received a very attractive bid using Texaco asphaltic cement. The contractors were the J. Rasmussen & Sons Co., of Oshkosh, Wis., and they started the actual laying of the wearing surface on July 15th and completed it on September 1st, laying approximately 75,000 sq. yds.

The writer knew that this type of pavement had been used successfully in other sections of the country, but was not aware of its use in a climate of such extreme temperature as is found at Stevens Point. During the time of laying this pavement the thermometer registered as high as 102 degs. in the shade, and during the winter of 1921-22 the thermometer registered many degrees below zero for a long period of time. The frost enters the ground at this city to a depth of 5 ft., and there is always much snow and ice upon the pavement for many months of the year.

Although the past winter was extremely severe at Stevens Point, the writer on inspection learned that the pavement was not injured by this severe weather and found the pavement in excellent condition and practically free from cracks, which are generally found in this type of pavement laid on a concrete base.

In laying this type of pavement, the engineer must be very careful in preparing the old base and disturb it as little as possible. If the base is not properly

TEXACO ASPHALTIC CONCRETE ON OLD WATERBOUND MACADAM PAVEMENT STRONG'S AVE., STEVENS POINT, WIS.

treated the wearing surface will not wear well.

In this case the old pavement was reshaped and properly rolled and made ready for the 2-in. wearing surface of the Texaco asphaltic concrete, which was laid in the same manner as when laid upon a portland cement concrete base.

The writer has noticed upon inspection of these pavements that on some streets there are no cracks in the wearing surface, and he believes that these streets are even better than those in which a concrete base is used.

As there are a number of cities in Wisconsin and elsewhere in the country having many miles of old macadam streets, this type of construction will surely be popular, and any city that fails to take advantage of their old macadam for a base will deeply regret it. They must bear in mind that any engineer can spend their money, but that it is the economic solution that should receive their attention in the future.

CONSTRUCTION AND MAINTENANCE OF GRAVEL ROADS IN IOWA

By C. Coykendall, Assistant Chief Engineer, Iowa State Highway Commission, Ames, Iowa.

The type of improvement most generally practical for secondary road systems is a gravel surfacing or sand-clay surfacing. It has been found during the past ten years that this type of improvement is in general more economical than waterbound macadam and more cheaply maintained under modern traffic. It therefore follows that there is probably no problem deserving of more thoughtful consideration on the part of highway engineers than proper methods of constructing and maintaining gravel and sand-clay roads.

In this discussion no fine distinction will be made between gravel and sand-clay construction. Satisfactory results can be obtained with either gravel or sand-clay construction if available material is used intelligently. Given ideal materials, the construction of any type of road is not a difficult problem. It requires a higher degree of engineering ability to get satisfactory results from the most available sources of material, even though such materials may be generally regarded as of inferior quality, than to require ideal materials without consideration as to the availability of such materials, and the resulting construction costs.

To Pave or Not to Pave

It is extremely difficult to determine where the dividing line between the construction of pavement and the construction of gravel roads should be drawn. There are a number of factors that must be taken into consideration in making this determination. Perhaps it would be well to enumerate some of these factors.

The Amount of Traffic

First, and primarily, the amount of traffic which must be handled, either present traffic which the highway is carrying, or the traffic that we can reasonably anticipate will be handled as soon as the road is completed. No one can state with any certainty the exact number of vehicles which a gravel road will handle in a satisfactory manner. All know from experience that there are roads on which the traffic can not be satisfactorily taken care of on such a surface. Likewise all know from experience that there are roads of secondary importance where a gravel surface serves every need of the traffic. Between these two points, however, there are many situations which are not so easily classified.

During 1919 and 1920 the State of Iowa in connection with the submission of Federal Aid projects did a considerable amount of traffic census work. Some of the roads on which a traffic census was taken had failed satisfactorily to take care of traffic as gravel roads. The traffic count showed that on the road south from Spirit Lake, which is perhaps the most popular summer resort in Iowa, there was an average daily traffic of approximately 915 vehicles. This road could not be satisfactorily maintained as a gravel road under this traffic. On the Jefferson Highway north from Des Moines the traffic count showed an average daily traffic of approximately 800 vehicles. It has been found that this road could not be satisfactorily maintained either as a gravel road or with a cinder surfacing. On a project in Howard County, which is some distance from the centers of population and carries only the ordinary county seat to county seat traffic, and a very limited amount of through traffic, the traffic count showed an average daily traffic of 238 vehicles. This road has been completed as a gravel surfacing project and is taking care of the traffic in a very satisfactory manner. The same is true of a project in Chickasaw County where the traffic count showed an average daily traffic of 216 vehicles.

We have reached the conclusion in Iowa

that where the daily traffic is not in excess of 500 vehicles per day, we can quite successfully construct and maintain a gravel surface. Where the traffic is in excess of this amount, however, maintenance costs mount rapidly and we are unable to give traffic service that is comparable to the service given by a properly constructed and maintained paved road.

Availability of Road Materials

Second, availability of materials for gravel road construction and maintenance; also availability of materials for paved road construction and maintenance.

Availability of materials determines in a large measure the economical type of improvement on any road. Where a good quality of gravel is available locally for gravel surfacing work, it is economical to construct and maintain gravel roads under conditions where it would not be economical if all such material for construction and maintenance had to be transported a long distance by rail, thereby greatly increasing the cost of construction and maintenance work. The real measure of the value of any type of road is the cost per ton mile or vehicle mile to the users of the highway. In determining this cost the availability of materials is an important factor.

Relative Usability of the Two Types

Third, the relative usability of the two types of road.

In considering usability we must take into account tractive resistance, satisfaction and convenience to the users of the road, and the safety of the road. Often we are justified in paving a road that can quite economically be taken care of by some cheaper type of construction, from a consideration of these factors alone. All have had experience in driving over a gravel road where the surface was in good condition but the dust was so bad that it constituted not only a nuisance, but an actual menace to traffic. All have seen gravel roads, especially during a long-continued dry spell, where the loose gravel which had accumulated at the sides and on the shoulders constituted a real menace to travel, particularly at night when meeting or passing other vehicles.

Gasoline Requirements

Experiments carried on by the Engineering Experiment Station at Ames, during the past year show that for truck traffic, a good concrete or brick surface requires 20 to 30 per cent less gasoline consumption per ton mile than is required for a road with a good gravel surface. Similar conclusions were reached in a series of tests carried on a few years ago by Professor A. N. Johnson, now with the University of Maryland. Hence it appears that on account of less surface resistance, actual operating costs to motor vehicle users are less on a good paved road than on a good gravel road, and this with other factors that are measures of the usability of a road are worthy of consideration in determining the proper type of improvement.

The Time Element

Fourth, the length of time that must necessarily elapse before a road can be paved.

It is often economical and expedient to gravel surface a road where traffic conditions will justify pavement in order to provide the traveling public with a usable road until such time as the pavement can be constructed. The building of a system of paved highways including five thousand to ten thousand miles is no small undertaking, even after the necessary legislative action has been taken and the necessary funds for financing the program have been provided. It takes time to develop an engineering organization capable of properly handling a large paving program. It takes time to develop sources of material sufficient to take care of a large paving program. It takes time to develop a contracting organization to do the actual work. From our experience during the past two or three years, during which time a large paving program has been under way, we can appreciate the fact that few states are organized to build more than a few hundred miles of pavement each year. The demand of the public is for "usable roads now." Consequently, in many instances we are justified in producing a large mileage of relatively cheap road which will give road users service during the time that must necessarily elapse before a large mileage of paved roads can be produced.

Legislative Machinery

Fifth, legislative machinery for building various types of road.

This is really the meat of the whole situation. We can not build roads except as we are authorized to do so by our state legislatures, and are provided with the necessary funds. Consequently in states where we are not authorized to build paved roads and in which funds for financing this type have not been provided, we must build the best type of road that has been authorized and for which funds have been made available.

Referring again to the situation in Iowa,

we can not build paved roads in any county in Iowa until the voters of that county have authorized the general policy of hard surfacing the primary road system of that county. If we are to make any material progress in those counties that have authorized the paving of the primary road system, a bond issue must also have been authorized. Consequently, in Iowa we are not in position, in all cases, to build the type of road which should be built from a consideration of the needs of traffic, nor is this restriction peculiar to Iowa alone.

This discussion up to this time has dealt only with factors covering the selection of the type of improvement. We will now assume that we have a road which is to be gravel surfaced, and will give consideration to the details of construction.

Alignment, Grade and Cross Section.

In gravel surfacing primary roads the same consideration as to alignment, grade and cross section applies as in the case of paving. There are many miles of our trunk line or primary road system that should probably be gravel surfaced before they are paved. Without doubt, however, the time is not far distant when this mileage should and must be paved. Consequently in building a gravel road we should attempt to determine upon a location and prepare a design as to grade, drainage structures, and cross section, which will prove satisfactory later on when the road is to be paved. It is quite generally recognized that the maximum grade for primary roads should not exceed 6 per cent, and should be made as much less than 6 per cent as topographical conditions will justify. Horizontal curves should be held as closely as possible to a maximum of 10 degrees. Right angle turns should be rounded with a curve of not less than 200 ft. radius, while a 300-ft. minimum requirement is better. In so far as is at all possible, the element of danger at railway crossings should be eliminated, either by grade separation or relocations of the highway which will eliminate the crossings entirely. The cross section should provide a minimum from 28 to 30 ft. width between shoulders with ditches at least 2 ft. below the shoulder line, and 4 to 6 ft. out from the shoulder line. A flat bottom ditch at least 2 ft. in width should be provided and back slopes made with whatever slope is required to prevent the ditches from filling.

On secondary roads less stringent requirements can be laid down as to grade, alignment and cross section. Grades and alignment should be the best possible to secure giving due consideration to the amount of traffic the road must carry. The cross section will vary between 20 and 30 ft., the limits depending upon the importance of the road, with substantially the same requirements as to ditches and back slopes outlined above for primary roads.

Drainage

Thorough subdrainage is absolutely necessary to successful gravel road construction and maintenance. It is probably even more essential on this type of construction than on pavement, inasmuch as the road surface itself has so much less inherent strength. Subdrainage can be secured either by the use of tile or by the construction of a grade which will bring the surface of the road well above the ground water limits. In all cases the surface of the road should be at least 2 ft. above the ground water level, and as much more than this as it is practical to secure. It is generally conceded by everyone at all interested in the road program in Iowa that thorough drainage is a primary essential to successful road construction. The people of Iowa are probably more nearly in accord on this point than on any other point in connection with our road building program. In the level sections of the state where natural drainage conditions are poor we ordinarily use more than a mile of tile drain per mile of road. During the 1921 construction season we laid more than one thousand miles of tile drain.

Material Specifications

Specifications for materials to be used for gravel road construction should be broad enough to admit any graveling material which by intelligent application can be successfully used in road construction. All states are not in accord with this but as stated heretofore, we believe that it is necessary to utilize to the fullest advantage the materials that are available. The maximum size of stone should not exceed 1½ ins. If this limit is changed, we would recommend decreasing it rather than increasing it. The amount of binder which the material may contain is extremely variable. As a general proposition the less binder that is used, the better. There are comparatively few instances where it is justifiable to haul binder for any considerable distance, inasmuch as substantially the same results can be secured by incorporating the loam, clay or gumbo of the road into the surface as binder.

Amount of Material Per Mile

The amount of material required per mile of road varies, of course, with the type of road being improved. Ordinarily between 1,000 and 2,000 cu. yds, per mile is enough. More material can be added from time to time as a maintenance measure. Consequently it is not advisable to place as a construction measure so much material that it is a serious problem to traffic properly to compact the material.

Handling of Construction Work

Gravel road construction work is very readily handled as a contract proposition if the specifications are properly drawn. The construction of the grade and the installation of the necessary drainage structures and tile drainage should not be tied up to the same contract as the gravel surfacing. Neither should maintenance by the contractor over any considerable period of time be required. The items included in the contract should be as few and as definite as possible. In our Iowa specifications the contractor bids on the following items: Stripping gravel pits, shaping subgrade preparatory to receiving the gravel, loading the gravel at the pit and hauling it one mile and spreading, and additional half-mile units of haul. The stripping of pits is on a yardage basis with a specified amount of work to be done.

It has been found economical thoroughly to prospect the source of supply before contracts are awarded for gravel surfacing work. From these investigations it is possible to specify with reasonable accuracy the amount of stripping that will be required, also whether or not the material must be screened and oversized material crushed. In the average deposit where there is not a large amount of oversized material, the price bid per cu. yd for loading includes the removal of oversized material at the pit.

All hauls of less than one mile in length are included in the price bid per cu. yd. for loading at the pit, as is also the spreading of the material upon the subgrade. When the haul exceeds 1 mile and is less than 1½ miles the price bid for each additional half mile haul is added to the unit price for loading. Similarly for each additional half mile that must be hauled the unit bid is proportionately increased. This method has been found more satisfactory and less confusing to contractors than bids based on average yard-mile hauls.

Before the gravel is dumped upon the road the subgrade should be flat and smooth. The gravel should then be dumped either on the shoulders or in the center, depending upon the time of year that the work is being done, and then spread the full width of the road. The material in the center should be spread thinly enough that traffic can travel down the center of the highway without serious inconvenience, immediately after spreading operations have been completed. We have not found the use of a roller practical in gravel road construction. Our most satisfactory results are secured by allowing the gravel to be compacted by the traffic, under continuous and intelligent maintenance. By spreading the gravel so thin that traffic is forced to the center, the shoulder lines are not destroyed nor is the element of danger to traffic introduced that is present when the gravel is windrowed down the center and traffic is forced to the shoulder line. As the center becomes compacted under traffic, loose material from the shoulders is worked toward the center of the road and the road gradually assumes the cross section intended, that is, a thickness of 5 to 7 in. at the center line shouldering out to a feather edge near the shoulder line.

It is often found during the process of compacting the gravel that the material used is deficient in binding qualities. Usually this difficulty can be remedied by harrowing, plowing, or otherwise mixing the material of the subgrade into the surfacing. It is believed advisable, however, to exercise considerable discretion as to the amount of binder used. Traffic should not be seriously inconvenienced by being forced to travel for a long period over a loose gravel road, but if some patience is exercised, both by the engineer in charge of the work and those using the road, it will be found that a more successful road will result from a sparing use of binder.

Maintenance

Under the construction specifications which have been recommended, it is very difficult to state where construction stops and maintenance work begins. As a matter of fact it is recommended that the maintenance organization take over the road as soon as the gravel has been placed on the subgrade, spread once and thoroughly mixed. The success of any gravel road is dependent very largely on the maintenance. Consequently, as soon as the gravel has been placed ,a well organized maintenance crew should be in position to take over the road and give it proper attention through the very impor-

tant stage that it is being compacted by traffic.

For the gravel roads which we can economically build from material available in Iowa, maintenance by a bituminous mat coat or by the application of bituminous materials is not recommended. Many of our materials have too large a percentage of fine material to make this system of maintenance successful. In fact, representatives of commercial interests primarily engaged in the manufacture of bituminous road materials do not recommend the use of such materials on many of the gravel roads in Iowa. This discussion will be limited to maintenance of gravel roads by methods other than by the use of bituminous materials without in any way entering into the merits of the use of such materials where a different type of gravel is available for the construction work.

Gravel road maintenance divides itself quite logically into two operations: First, the maintenance of material placed during construction, and second, maintenance by applying additional material. Both operations are necessary. We must expect to renew from time to time the material which is lost either by the action of the elements or by gradually being forced into the subgrade. On our most heavily traveled gravel roads in Iowa the annual replacement of surfacing material is from 300 to 500 yds. per mile per year.

Patrol Maintenance

For keeping gravel road surfaces in good condition the patrol system of maintenance is strongly recommended; that is, a patrolman equipped with a patrol blade grader and other incidental tools should have full charge of the maintenance of a certain section of gravel road. The length of this section is dependent upon the importance of the road and the amount of traffic which it carries. For heavily traveled roads ordinarily five to six miles is the maximum which a patrolman can take care of. The surface of a traveled gravel road requires constant attention, regardless of weather conditions. The best results in filling chock holes that develop are secured after it rains, but the prevention of the development of chuck holes is dependent largely on the care the road receives during the dry weather periods. If a film of loose material can be kept on the surface of the road, it will be found that this film of material really bears the brunt of the traffic and prevents ravelling of the surface of the road. Naturally if a film of loose material is to be kept spread over the surface, continual attention on the part of the patrolman is required, as traffic tends to whip this loose material to the center and to the shoulder lines.

Gang Maintenance

The efforts of the patrolman must from time to time be supplemented by what is ordinarily styled gang maintenance. The patrolman is not equipped to do heavy work such as opening ditches or building up the shoulders. It will be found on a heavily traveled road that from time to time an accumulation of loose material has taken place on shoulders and that it is very difficult to get this loose material to pack in the center of the road. In those cases it is often necessary really to reconstruct the road ;that is, the loose material that has accumulated on the shoulders should be forced to the center of the road, the shoulders built up from material taken from the ditches, and the gravel re-spread from shoulder line to shoulder line. For this work, a 12 ft. blade grader drawn by a tractor is very effective. It will be found in this operation that the material taken from the ditches acts as new binder, and that better success will be had in getting the gravel compacted. Quite often this process should be supplemented by the addition of a maintenance course of material. In fact, this process practically always should precede the adding of a maintenance course of material.

Gravel Maintenance of Earth Roads

We experimented in Iowa during the year 1921 with a so-called gravel maintenance of earth roads. That is, an earth road that has been properly graded and drained is given a very light surfacing of gravel—approximately 500 cu. yds. per mile. We have not considered that with this much material we have been building gravel roads, but we have been making earth roads much more usable for eleven months, at least, out of every year. The addition of the gravel to the top soil of the road makes the gumbo soil or heavy clay soil much more easily maintained under heavy traffic. It also makes the surface of the road impervious to ordinary summer rains.

The cost of this kind of maintenance where gravel is locally available is not heavy, and it is expected that on roads where a 500-yd. maintenance course was placed in 1921 an additional 500 yds. will be placed in 1922, and in time we are quite likely to have "maintained" an earth road into a gravel road. Material used for this kind of work should all pass

a screen with 1 in. openings. We are much interested in the possibilities of this type of road work and expect to try it on quite a considerable mileage during 1922.

Conclusions

In conclusion we have these points which should be emphasized in connection with the construction and maintenance of gravel roads:

First, do not lose sight of the importance of this type of construction. For years to come this type of road will undoubtedly constitute the greatest percentage of the surfaced roads that are built.

Second, make the maximum use of available materials. Have your specifications as to materials flexible enough to allow the use of any graveley material which with intelligent construction and maintenance methods can be advantageously used for gravel road construction.

Third, draw the specifications in such a manner that the construction of gravel roads is a readily contractable proposition. Do not require the construction contractar to do a lot of maintenance work for which he has neither equipment nor the experienced organization so necessary for satisfactory gravel road maintenance.

Fourth, do not expect satisfactory results from any gravel road unless thorough and systematic maintenance can be given. A gravel road is no better than the maintenance it receives.

The foregoing matter is from a paper by Mr. Coykendall, presented at the latest annual meeting of the Highway Engineers' Association of Missouri.

INGENIOUS METHODS EMPLOYED ON HIGHWAY BRIDGE RECONSTRUCTION AT MILPORT, INDIANA

Lengthening a bridge 70 ft. by adding a steel span procured sixty miles distant, persuading the contractor of a dredging project to dismantle his machine in preference to tearing down the bridge under which it would not pass, all accomplished at a saving of $33,000 over the cost of a new bridge equally as good, is a unique feat in bridge engineering in the state highway department in Indiana.

This bridge rebuilt through modern enginering methods, spans the Muskatatuck river at Milport, half way between Seymour and Salem, and is on state road 24. Flood waters of several seasons showed the river was too narrow, so county commissioners contracted to widen the stream by dredging.

The highway commission negotiated with the contractor to dismantle his dredger, and the department removed the dirt within the state's right-of-way. The bridge was lengthened, an action necessitated by widening the stream, by adding a span taken off a bridge on another state road near Southport.

The Milport bridge is near the famous Milport Knobs, immediately south of the river on the Salem road. This old road is identified with the history of this section when Indiana was a part of the Northwest Territory. The road is said to have been laid out by French military engineers. The old bridge was built in 1884. While in fairly good state of preservation, it would not have been practical to have re-erected it had it been necessary to raze it to permit the dredger to pass, William J. Titus, chief bridge enginer of the department, says.

In making this bridge capable of meeting traffic requirements for several years, a new floor was laid, steel work cleaned and painted, and the contractor, an Ohio firm, tightened the truss members in a most ingenious manner. A forge was placed at the center of the rods, the steel heated to proper temperature, and forced together by driving the rods from either end. The old stone abutment was removed and a new concrete pier and abutment laid to care for the additional span. The old abutment rested on hewed logs floating on soft clay, the engineers say. The new concrete pier and abutment were placed on 35-ft. piling driven to solid rock approximately 50-ft. below the water level.

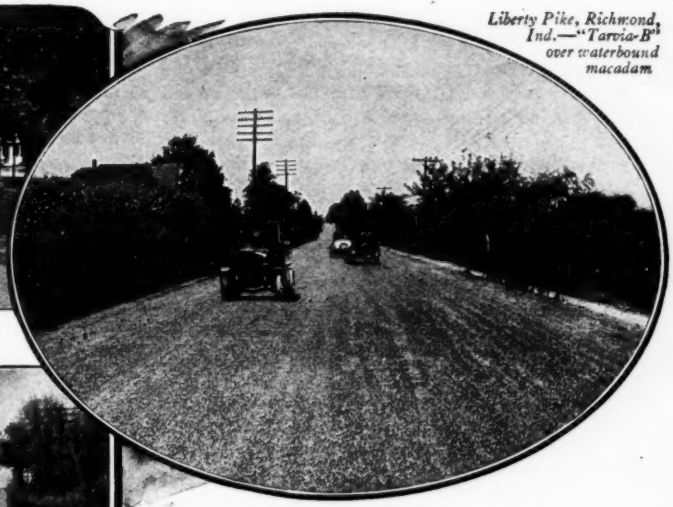
The contractor's price on repairing this project was $17,000. It would cost $50,000 to build a new bridge as serviceable, according to highway officials.

THE USE OF BLACK BASE

By Frank B. McGrane, 16 College Hill Road, Somerville, Mass.

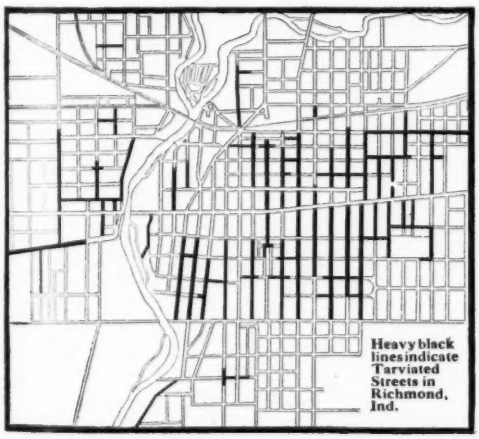
After being forgotten for a couple of decades, asphaltic concrete base is again coming into general use. A foundation that was discarded for no apparent reason, other than the mistaken idea of the necessity of a rigid base for the asphalt

North 15th Street, Richmond, Ind.—Macadam maintained with "Tarvia-B"



Liberty Pike, Richmond, Ind.—"Tarvia-B" over waterbound macadam

Chester Pike, Richmond, Ind.—Macadam maintained with "Tarvia-B"



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pavement, is again finding favor with the engineer.

Black base that was laid 30 years ago was recently removed for the purpose of changing grade; its state of preservation was remarkable, showing absolutely no deterioration thereby exploding the theory that contact with dampness or water soon ruins a mixture containing bitumen.

Difficulty in obtaining portland cement during the war led the Engineer to resort to the first base used for the asphalt topping, the base that offered none of the objections of the rigid base. When black base was laid 30 and 40 years ago little was known of the qualities of asphalt binder for paving purposes. Today we have the benefit of many years of research on the part of some very able men.

In the laying of asphaltic concrete base the mixture should not be thought of in terms of portland cement proportions, such as 1-3-6 or 1-2-4. The percentages of ingredients will have to be determined by traffic and available supply of sand, gravel or crushed stone. The amount of bitumen is, of course, gauged by the carrying capacity of the aggregate. Proportions must not be haphazard, but weighed in a modern manner and mixed until every particle is coated unformly and a homogeneous mass is produced.

While the tendency today is to insist upon the pug-mill type mixer, which for the finer mixture is essential to good work, it may not apply to the coarse aggregate used in black base. When one takes into consideration that stone or gravel up to 2½ ins. will be used, it will be seen that considerable damage to the pug-mill type is the likely result; the breaking of mixer blades and the ripping of the mixer liner would be a common occurrence. The cylindrical or cube mixer would here be advisable in the opinion of the writer.

The question may be raised: if the cube or cylindrical mixer is not good for the top, how can it be satisfactory for the foundation? Consider the difference in the mixture and the reason becomes readily apparent.

Asphalt surfacing or topping is a mixture of fine sand and filler (which may be either portland cement or stone dust.) Such a combination possesses billions of particles in a single batch each of which must be completely and uniformly coated with bitumen. In the cylindrical or cube type mixer there is a strong tendency for the finer particles to separate and form balls after the bitumen is poured into the mixer or during the mixing process. This of course, means nonuniform distribution of bitumen among particles with consequent weakness. Again should the aggregate be below a good working temperature the bitumen will likewise be reduced to this state, and it follows that the colder it becomes the greater its cohesion and the greater the cohesion the more resistance is offered to mixing. In this condition a homogeneous mass is beyond this type of mixer, whereas in the pug-mill the heavy revolving blades churning through the mass at about 70 revolutions per minute, break up balling and overcome the cohesive resistance offered by the bitumen.

In black base the particles are many times reduced to a minimum, much less surface is to be coated and the amount of bitumen is considerably reduced. Again, owing to the reduced number of particles, the cohesiveness between particles or resistance to mass mixing is reduced to such an extent that a good batch can be obtained in the cylindrical or cube type. For best results not less than 15 r. p. m. should be reduced and mixing should continue at least 1½ minutes to the batch. Mixed material should be hauled to the job in vehicles covered with canvas or other suitable material. Upon arrival on the street or road the concrete should be dumped on a platform, never on the subgrade. This prevents the chance of mingling or mixing the soil in the material which of course would cause weakness in the structure. Should the haul be a long one the coarse aggregate will settle in transit. If the mixture is rich in bitumen this will come to the surface; when dumped on a platform the shovelers must turn the material over when depositing for the rakers who should so handle the load that no spot will contain an excess of asphalt, otherwise a soft spot is likely to result.

Rolling black base should be done with a heavy roller, preferably the 3-wheel type. Only sufficient water to prevent sticking should be used. An excess of water brings the bitumen to the surface. The reason for this is that water causes fermentation. The result of such action would mean a soft plane of contact and possible shifting of surface topping.

For a good result follow black base closely with the surface material. The best construction is obtained by laying the topping before the base cools.

WATER WORKS SECTION

NEW WATER PURIFICATION AND PUMPING PLANT AT PRYOR CREEK, OKLAHOMA

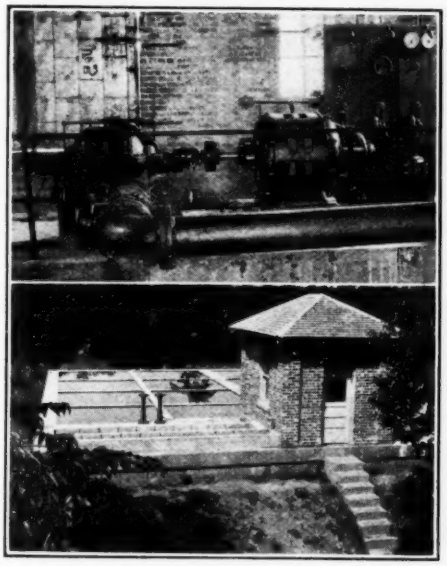
By L. M. Bush, of V. V. Long & Co., Consulting Engineers, 1300 Colcord Bldg., Oklahoma City, Okla.

The city of Pryor Creek, Okla., is located in Mayes County, about seven miles west of the Grand river, from which stream its water supply is obtained. The Grand River has a swift current and a large flow at all times of the year. There are no towns or cities of any size, which discharge their sewage into this stream, closer than Miami some sixty miles above, and due to the large flow at all times the river water is in a fair condition when it reaches the Pryor Creek Pump Station. Tests by the laboratory of the State Board of Health, have found a low bacterial content but the test has characterized the water as suspicious.

The city of Pryor Creek has a well-metered water service but a large consumption. Daily consumption averages 300,000 G. P. D. during the winter months and 400,000 G. P. D. during the summer. The M. K. & T Railroad Company purchases water from the city.

For several years, the pumping equipment has consisted of two 750 G. P. M. reciprocating steam pumps, pumping water directly from the river through pressure filters to the stand tower in town. It became necessary to discontinue the use of the steam pumping plant due to the fact that coal had to be hauled ten miles from the city of Pryor Creek and this made the cost of steam power excessive. The discharge head averages 325 ft., and the suction lift, at low water stages, is 19 ft. This installation has worked well at times when the river water was clear, but at times following rains it has been impossible properly to clarify the water, due to the lack of any provision for coagulation after the addition of coagulants to the pump suction. In extreme cases it has been necessary to wash the pressure filters every few hours in order to supply water that would be even reasonably clear. At these times the supply in town decreased to such an extent that the storage in the city was frequently very low.

In September, 1921, contracts were let for the construction of a new settling basin and the installation of motor-driven centrifugal pumping units. Power is being supplied by the local utility company over a 13,200-volt transmission line. A 500-g.p.m. low lift single stage centrifugal pump, operated by a 15-h.p. motor, pumps the water from the river to the settling basin. A 500-g.p.m. high-service three-stage centrifugal pump, driven by a 75-h.p. motor, pumps the water from the settling basin through the pressure filters to the standpipe in the city, seven miles distant. The settling basin has a capacity of 200,000 gals. and is designed for a retention period of six hours at periods of maximum consumption. The agitator consists of four compartments and wooden baffle boards. The feature of this design is the



VIEWS OF WATER PURIFICATION AND PUMPING IMPROVEMENTS AT PRYOR CREEK, OKLA.

High Service Pumping Installation; 500 G.P.M. 3-Stage American Well Works Centrifugal Pump Direct Connected to 75 H.P. Westinghouse Motor-Coagulating Basins and Chemical House.

short retention period in the agitator, being ten minutes. Powdered alum is used as a coagulant being fed to the agitator through a chemical machine having variable speeds. At the time of the test, a solution of 1½ grains per gallon, was used with very good results in clarifying the water in the basins. Another feature of the installation is the use of a manual solution feed chlorinator for adding liquid chlorine to the filtered water under 110 lbs. pressure. The chlorinator is installed and feeds into the discharge main to the city and is operated by a 3-h.p. motor.

The settling basins are constructed of reinforced concrete and are located at sufficient elevation to permit the use of gravity filters to be installed at some future time. A Pittsburg Dry Feed Chemical machine is used. American Well Works Pumps direct connected to Westinghouse motors, were purchased. A 13,200 volt, 3-phase transmission line, furnishes electrical power for operating the plant from the Public Utility Company's Power Plant in the city of Pryor Creek.

The plant was designed and its construction supervised by V. V. Long & Co., Consulting Engineers, Oklahoma City, Oklahoma. The construction work was in immediate charge of R. D. Morgan, Water Superintendent for the city of Pryor Creek. The Ajax Construction Co. of Lawton, Okla., were the contractors for the work.

FINANCIAL GAIN FROM IMPROVING OLD WATER SYSTEMS

By Lawrence W. Cox, Civil Engineer, 1102 York St., Des Moines, Iowa.

During the past year the writer has collected considerable data relative to the water supplies and water consumption of a number of Iowa cities. Many of the smaller cities were found to have supplies that were not satisfactory. At some of the cities, the supply was scanty, but of good quality, at some, the supply was abundant, but the quality of water was poor, while at other places the supply was not only scanty, but the quality of the water poor. In only a few places visited, was the supply found to be both abundant and of good quality.

The data collected confirms the fact that the per capita consumption of water increases appreciably with both the quality of the water and with its abundance. Water rates no doubt have their influence, but no matter how low the rates, if the supply is known to be scanty, muddy, highly mineralized, or otherwise poor, prospective consumers have less incentive for connecting up, and those consumers that are connected up, use less freely than they would otherwise do. On the other hand, many cities with adequate supplies of water of good quality, have good per capita consumption, even with high water rates.

Table I gives a record of ten municipalities ranging in population from 1,738 to 8,034, all within the same section of the state and all of a residential character.

Regardless of the moral obligation which city officials owe the citizens of their communities, to see that the public water supplies are sanitary, and regardless of the necessity of a copious supply in order to maintain dependable fire protection and continuous service to such patrons as are dependent upon it, it is in many instances nothing less than good business to make the necessary investments for improving their supplies. In Table I, the systems with the lower per capita consumptions, are not self-supporting, while those with the higher per capita consumptions are self-supporting or even making money. The dividing line varies of course with the investment in plant and operating costs, but is not far from 50 gals.

While it appears from Table I, that the larger per capita consumptions are among the larger cities, it is also seen that these

TABLE I—WATER SUPPLY AND CONSUMPTION IN 10 IOWA TOWNS

City No.	Population 1920	Gals per Capita per Day	Character of Supply
1.	1,738	23	Impounding reservoir, muddy, polluted water, supply sufficient for normal years only.
2.	2,193	25	Deep well, water highly mineralized, supply scanty, water rate high.
3.	1,787	26	Impounding reservoir, water coagulated with alum, not filtered, supply scanty.
4.	2,684	27	Impounding reservoir, muddy, polluted water, supply adequate.
5.	1,840	34	Impounding reservoir, water coagulated with alum, not filtered, supply adequate.
6.	2,111	47	Wells, quality of water fair, supply scanty.
7.	5,175	50	Impounding reservoir, water filtered, abundant supply, system in service only a few years, consumption will continue to increase
8.	8,034	75	Impounding reservoir, filtered water, excellent quality, abundant supply.
9.	5,255	76	Well water, good quality, adequate supply.
10.	4,511	77	River water, filtered excellent quality, abundant supply.

TABLE II—FINANCIAL STATEMENT OF TYPICAL WATER WORKS IMPROVEMENT

Items	Present Plant	Improved Plant
Total Investment	$50,000	$110,000
Interest on $40,000 @ 5%	$ 2,000	$ 2,000
Annuity to retire the above	750	750
Interest on $60,000 @ 5%		3,000
Annuity to retire the above		1,450
Help at office and plant, light, heat, rent, chemicals, repairs, etc.	1,300	2,800
Total yearly expenses	$ 4,050	$ 10,000
Received from hydrant rental	500	500
Amount that must be raised from sale of water	$ 3,550	$ 9,500
Total water pumped per year, millions of gallons	14.60	38.00
Water not accounted for, 20%	2.92	7.60
Net amount of revenue producing water	11.68	30.40
Cost of water per 1,000 gallons	30.4c	31.3c
Actual average water rate per 1,000 gallons	15.4c	35.0c
Actual revenue from water sold	$ 1,800	$ 10,640
Actual loss, to be raised by levy	$ 1,750	
Actual profit		$ 1,140

happen to be the only cities with adequate supplies of wholesome water. Certainly a per capita consumption of 60 gals. per day can be counted on for an adequate supply of good water, after the first few years of service.

Taking this rate of 60 gals. per capita per day, as a basis, we have made an estimate of the financial benefit to city No. 1, which will result after adding an impounding reservoir and purification works, so as to make their supply both abundant and of good quality. With their present system the supply is not only limited but the water is so muddy at times that it can not even be used for laundry purposes and the mud clogs meters so badly that the meter system has been given up and a flat rate substituted. This flat rate brings in a yearly return of only $1,800 (about 15.4c per 1,000 gals.) Even with this low rate many patrons object to their bills, due to the poor quality of water, while on the other hand cities with the higher rates of consumption have rates of 35c to 40c per 1,000 gals., for domestic users, and principal source of revenue.

The financial statement in Table II is based on the following:

Present yearly revenue from water, $1,800.

Actual investment in present system, $50,000, (actual present value about $100,000).

Bonds outstanding, $40,000, which we assume will be retired at the expiration of 15 years, by the proceeds from an annuity or sinking fund, drawing 4 per cent compound interest. The bonds to draw 5 per cent interest until paid.

Cost of additional impounding reservoir and purification works, suitable for the next 30 years, $60,000.

These bonds to be retired at the expiration of 30 years from the proceeds of an annuity or sinking fund drawing 4 per cent compound interest. The bonds to draw 5 per cent interest until retired.

Rate of consumption at present, 23 gals. Average future rate of consumption, 60 gals.

It is here seen that this water works system which is now an expense account to the city, can by the expenditure of $60,000, be converted into a money-making proposition, after the first few years of operation, and at the same time supply a water which the city officials can offer to the public with just pride.

PENNSYLVANIA AND NEW JERSEY ADOPT UNIFORM POLICY REGULATING DISCHARGE OF SEWAGE INTO THE DELAWARE RIVER

(Editor's Note:—The Delaware River forms the boundary between the states of Pennsylvania and New Jersey. During the past few months inspections of the Delaware River have been made and conferences held between the engineers of the Pennsylvania and New Jersey Departments of Health. As a result of these studies a uniform policy as to the degree of treatment of sewage discharged into the Delaware River was formulated and has been approved by the Commissioners of Health of the two states. The statement of the adopted policy, for a copy of which we are indebted to Mr. W. L. Stevenson, Assistant Chief Engineer of the Pennsylvania Department of Health, is presented herewith.)

1. Sewage discharged into the Delaware River from the northern limits of the State of Pennsylvania and New Jersey to a line above the City of Easton and the Town of Phillipsburg shall be treated to

such an extent as to produce a clarified and oxidized effluent; and also, that so far as legally possible, the State Department of Health will prevent the discharge of untreated industrial wastes into this portion of the river.

2. Sewage discharged into the Delaware River from a line above the City of Easton and the Town of Phillipsburg to a line above the borough of Morrisville and the City of Trenton shall be treated to such an extent as to effect the removal of settleable matter by means of efficient sedimentation; provided, however, that in cases where such settled sewage may be discharged into this portion of the river that it may prejudicially affect a water supply, the effluent shall be further treated adequately to safeguard the purified water supply obtained from the river; and further provided, that when plans for sewage treatment works are approved, where the sedimentation of sewage is the only treatment required under this policy, the approval shall be subject to the condition that means for the further purification of the tank effluent shall be installed when deemed necessary by the State Department of Health; and also, that so far as legally possible, the State Department of Health will restrict the discharge of untreated industrial wastes which might be a menace to public health or create a nuisance to either sight or smell.

3. Sewage discharged into the tidal portion of the Delaware river, from and including Morrisville and Trenton and to and including Philadelphia and Camden, shall be treated by means of sedimentation and the effluent discharged through submerged outlets into deep water in the Delaware river; provided, however, that in cases where such settled sewage is or would be discharged into the said tidal portion of the Delaware river at such a distance above or below a water work's intake that it may prejudicially affect such water supply, the effluent shall be further treated adequately to safeguard the purified water supply obtained from the river; and further provided, that when plans for sewage treatment works are approved, where sedimentation of sewage is the only treatment required under this policy, the approval shall be subject to the condition that means for the further purification of the tank effluent shall be installed when deemed necessary by the State Department of Health.

3-A. From data now available it is considered that the discharge of only settled sewage into the aforesaid tidal portion of the Delaware river within two miles of a water work's intake of an efficient filtration plant may prejudicially affect such water supply.

4. In case the said point of sewage discharge is from one state and the said water work's intake is in the other state, so that the sewage effluent while discharged within the aforesaid two miles would have to cross the river to reach the water intake, then before a decision is reached by the State Department of Health having jurisdiction over the discharge of sewage, the case shall be taken up with the other State Department of Health for a careful determination of the probability of the discharge of only settled sewage prejudicially affecting the water supply.

THE SANITATION OF RURAL SCHOOLS

By Wm. R. Conard, of Conard & Busby, Consulting Engineers, Box 310, Burlington, N. J.

A recent count on a trip of about 90 miles, which took us past 12 schools, situated in rural or semi-rural communities, indicated that of that number 10 appeared to have no other sanitary conveniences than the old-fashioned well and privy, and this trip was made through a section inhabited by persons of intelligence and a fair degree of education. This condition being allowed to prevail in this day and generation when by the present means of communication practical city conveniences can be easily secured, and when modern sanitary knowledge is being so widely distributed, and when medical science tells us that children of school age are among those most susceptible to all of the intestinal diseases, is indeed a sad commentary upon our Township and Rural Community school authorities, and the Architect who is usually retained to advise with them.

Few indeed are the schools which are so situated that it would be impossible to install a driven well, whether shallow or deep, from which usually a good potable water might be obtained and in connection with which a hot air, gasoline, or kerosene driven engine, and pump, and in many places an electric motor and pump, together with modern plumbing and pressure tank, could not be installed. And also few there are of these same rural or semi-rural schools that are so situated that they could not have the toilets indoors, and connected to a modern

system of sewage disposal, either by discharging into a cess pool, digesting tank and chamber and from there into underground drains known usually as French Drains, or else into the more modern settling tank and small sludge bed with the liquids flowing away either to French drains, or similar means of filtering and disposing of the liquids.

All this may sound rather fearsome to the layman who has not been accustomed to these things, and I can almost hear him saying: "That is all very well, it sounds modern, up-to-date, and would put us on a par with city folks, but, my, how it would cost! Besides, what was good enough for our parents, and ourselves, is good enough for our children." Such opponents of progress never stop to consider that the life of one healthy person is of more value to our country than the cost of many sanitary systems.

Let us figure what it probably would cost, taking for example a school for 100 pupils located out in the country where the haul for materials would be, say, 5 miles, and where the soil conditions make it possible to get good water from a well not over 60 ft. deep in which the water rises to within 20 ft. of the surface. Suppose we allow $100 for the well. We can get a pump, a pressure tank, and the motive power for the pump for $200, and plumbing and sanitary conveniences sufficient for that many pupils for probably another $200.

For the disposal of the sewage for an average condition this should not cost more than the water system, and in most instances the installation could probably be such that there would be practically little or no maintenance costs. Then the school will have a modern, sanitary convenience for the pupils for about $1,000 or $10 per pupil capacity. Let us figure how this improvement can be paid off and consider whether the cost is worth the investment. The cost of maintaining in good repair these conveniences would be little more than the cost for maintenance and repair of the older kind of conveniences, so that the first cost with the interest on the investment would be practically all that it is necessary to figure. Suppose we figure to pay the entire amount off in ten years, as at the end of that length of time there would probably have to be repair and replacements of parts. The first year it would cost the School District $1.60 per pupil yer year and this would decrease year by year until the last payment when the payment would be $1.00 per pupil. This is surely not an extravagant amount to spend on our children, when we consider the benefits to be derived, and when considered from a taxing standpoint it surely ought not to be beyond that which the school district could stand and should be willing to pay for.

PNEUMATIC PUMPING UP TO DATE

By John Oliphant, Chief Engineer Pneumatic Pumping Department, Sullivan Machinery Co., Peoples Gas Bldg., Chicago, Ill.

It is very rare for the pumping engineer to find a complete record or log of a well —while perhaps the wells are the most important thing about a municipal or industrial plant, the contract for the work seems to be let in a haphazard manner and no record required from the driller as to what class of material he penetrated—where it was located, and its thickness, to say nothing of the kind and size of casing and strainers used. It is no uncommon thing to go into a well that has been represented to be of a certain size, to the bottom, and find it has been reduced, sometimes more than once. This entails considerable loss of time and expense to secure equipment that will go into the hole.

A driller should be required to furnish a complete log and this should be as carefully preserved as the deed to the property.

Constructing a Well in a Sand or Sand and Gravel Formation

The standard practice of well drillers is to equip gravel and sand wells with a strainer, designed to shut out the sand from the working barrel of a deep well pump. In time, these strainers become clogged with sand and the flow into the well is thus reduced. By a system of back-blowing, the output from such wells can be permanently increased.

The correct strainer for wells of this class, pumped by the air lift, is a perforated screen with openings of a suitable size to admit the fine material into the well, from which it can be pumped, and to hold back the coarser particles, so as to form a natural gravel filter bed outside of the artificial one.

The force available for getting water into a well is the head, due to the difference between the static level in the water strata outside the well, and the pumping level in the well, minus friction due to the strata and screen. Therefore, the more this friction can be reduced, the greater will be the flow, providing, of course, that an abundance of water is available.

"Back-blowing" can be applied to all wells. The top of the well casing should be sealed; next, by closing the discharge pipe while the air lift is in operation, the air will be forced through the foot piece and will drive the water ahead of it through the strainer and float the finer sand. Then, by opening the discharge, the flow will resume its course toward the surface and bring a portion of the floating sand with it. By a repetition of this operation and by increasing the back pressure if necessary, all of the fine sand immediately outside of the strainer will be collected outside of the screen in such quantities as to shut off the sand and increase the flow into a well, without changing the piping in the well. This process may be repeated at any time, so that the screen and adjacent strata can be kept clear.

When wells are drilled in rock, the action of the drilling tool forces the cuttings back into the crevices in the rock. These may be loosened and pumped out of the well in the same manner.

In the case of wells in fine material and quicksand it is often possible to set a strainer in the sand and drill auxiliary holes alongside the well down to the top of the strainer. Then foreign gravel may be dropped down, which will roll in alongside of the screen and take the place of the sand pumped out—often increasing the yield four-fold, by affording outside of the gravel bed a larger area through which the water may leave the sand.

Pumping From Wells With Compressed Air

This method of pumping is becoming more generally used and is deservedly popular for several reasons:

First. That more water can be secured from a given well than by any other method—as high as 2,200 gals. per minute being secured from a 12-in. well.

Second. The character of the water is improved (due to aeration) as to purity and solubility. Recently a very prominent firm of consulting engineers for one of our large cities found that the treatment for the removal of iron was so much less expensive where the water had been lifted with air that they recommended its use—in spite of an apparently higher pumping cost.

Third. It is a well-known fact that the expanding air absorbs heat from the water and a reduction in temperature is secured. In some ice plants this method is being installed for re-pumping surface water for condensing purposes.

Fourth. As there are no moving parts in the well, no deterioriation is caused by mud, grit, floating sand or long shut downs.

Fifth. As long as the pumping conditions are maintained a sustained efficiency is secured over a long period of time, practically the life of the pipe—and if the conditions change and the pumping head drops, a very small expense is required to re-adjust the system to these new conditions.

Sixth. The fact that a large system of wells covering an extensive area can be operated from a central plant.

The question of submergence is one of the first things to be considered. In actual practice it is found that various submergences can be used for the same lift.

"Submergence" is a term used to express the water head about the point at which the water is admitted to lighten the ascending column—and may be in the well or in the strata adjacent to the wells. It is expressed in per cent, 100 per cent being the vertical distance from the point at which the air enters the water until it leaves it. While there is no definite division line—the following proportions of submergence will be found effective.

Lifts	Submergence
up to 50 ft.	70% to 65%
50 to 100 ft.	65% to 55%
200 to 300 ft.	55% to 50%
300 to 400 ft.	43% to 40%
400 to 500 ft.	40% to 35%

In proportioning a properly balanced air lift installation there are two principal factors to be considered—slippage and friction. As one is reduced the other is increased and the proper balancing of these two elements of loss makes the most effective installation.

The slippage of a bubble of air through water is in proportion to its size—the larger bubbles slipping faster than the smaller ones. It will readily be seen, therefore, that breaking the air up into small streams and the forming of an emulsion at a point nearest to where the air enters the water is a distinct advantage.

The question of friction is also of paramount importance in determining the areas of the discharge pipe. As there are two elements to be handled, air and water, it is necessary to consider their combined volume. The amount of air depends upon the lift and submergence, therefore the volume handled in the dis-

charge pipe—not only changes with the lift, but also changes with the submergence for the same lift. The proper size of piping for handling a certain amount of water under various lifts and submergences is one that should be taken up with a practical engineer having experience along this line of work, as there are so many variants that a cut and dried set of rules is likely to be misleading. Another point in regard to a properly installed air lift, that is rarely given the important consideration that it should have, is the smoothness of the dscharge piping.

Ordinary commercial piping does not butt joints in the couplings but leaves a considerable space between the two ends of the pipe, the water and air traveling at a high velocity-especially towards the upper part of the lift, and where the bubbles have expanded to a larger size, strikes the edge of the upper pipe in each coupling, thus causing a swirl and a considerable loss in slippage, amounting at times to 10 per cent.

And where a central air line is used the trouble is augmented by the couplings of the air line.

Inserted joint casing or butt joint and pipe should be used for the discharge line and also for the air line, where the central system is used.

As the bubbles of air travel with the water to the point of discharge they increase in size, as the head over them is reduced, and consequently occupy more space in the ascending column and it is often an advantage to take care of this increased column with an increased area of discharge pipe. This increase in volume is not uniform but is much more rapid towards the top of the discharge and is frequently the cause of the unequal or plugging discharge which is inefficient and unsatisfactory. The upper part of the column moving faster, gets away from the bottom and an interval in the discharge of water occurs. A properly expanded pipe will generally correct this—but the expansion should be toward the top of the discharge line.

Summary

I have tried to emphasize the fact that while the air lift is apparently a simple installation there are many features about it not generally known—and thousands of dollars in coal would be saved annually if careful consideration were given to these facts.

It will certainly pay a municipality or manufacturer having an air lift plant or contemplating installing one—to have the matter studied by some one who has had practical experience along these lines.

The foregoing matter is from a paper by Mr. Oliphant before the 1922 annual convention of the American Water Works Association.

SERVICE AS AN ELEMENT IN RATE MAKING

By Carl Wilde, Director of Service, Public Service Commission of Indiana, State House, Indianapolis, Ind.

The principle fully recognized and applied that the character of service rendered by a utility should be taken into consideration as an important element in determining its rates, is of great assistance to the Service Department in that it aids that Department to induce utilities to adopt proper standards and rules of service.

This principle has been recognized by various commissions for some years. On Dec. 30, 1915, the Wisconsin Commission denied a telephone company the right to increase its rates on a line serving only a few subscribers, giving inadequate service and yielding an inadequate rate, until adequate service be established and a reason able effort be made to secure additional subscribers. The Commission said further that if the telephone company should prove unable to give satisfactory service after a reasonable trial period, the Commission would not then oppose the extension of the line of a competing telephone company into the district in question.

In 1919 the Nebraska Commission, in establishing a new schedule of increased telephone rates for a utility operating in several communities made an exception to the general rate increase in favor of subscribers connected with a certain line, where the evidence showed that the line was in very poor service condition.

The Arizona Corporation Commission has ruled that in considering the adequacy of telephone rates, service is one of the principal features to be borne in mind, the subscribers as a rule being willing to pay properly for service which meets their needs adequately.

My own experience in the Service Department of the Indiana Commission has convinced me that this is true. I have been told time and again by utility patrons that they would not object to paying an adequate rate if the service they received was adequate, but that they objected strenuously to paying adequate rates for inadequate service.

The Michigan Public Utilities Commission has also laid down the principle that the quality of the service rendered by a telephone utility should be a vital factor in the determination of its rates.

The Oregon Public Service Commission in discussing the relation of service to rates said:

"This Commission naturally concedes the relevancy and importance of a financial showing, but certainly not to the exclusion from our consideration of the general service conditions and other circumstances surrounding the case, and in this order we must, in fairness and equity to the company's patrons, emphatically reaffirm that the adequacy of the service bears a direct and important relationship to the reasonableness of the rate."

The Missouri Public Service Commission has enunciated the same doctrine, using in one case the following language:

"The subscribers should not be required to pay for the service more than it is reasonably worth. The extent or quantity as well as quality of service must be considered together in their relation to each other, because it is apparent in the record of this case, that the quality of the service has been affected by the extent or scope of the service."

In a case which directly concerned water rates the Missouri Commission said:

"It is the duty of the company to make whatever additions and alterations are necessary to provide not only for the domestic consumption, but as well for fire service by direct pressure, and when the company is prepared to discharge this duty, and not until then, it may properly claim such rates as may be necessary to provide for a net return on the investment used and useful in the public interest.

"The water company is not rendering such reasonable fire service as the city is entitled to receive; the granting of rates which will produce a fair return on the investment used and useful in the service of the public is predicated upon the furnishing of reasonably satisfactory service, and until the company is prepared to furnish such service, it is not entitled to an increase in rates and charges for water service."

The principle that the character of service rendered by a utility should be taken into consideration as an element in rate-making has been discussed in various cases by the Public Service Commission of Indiana.

In its Cause No. 5107, which arose upon the petition of a water utility for increased rates, the Commission used the following language:

"The Commission is of the opinion that while petitioner is entitled to increases in its water rates, the patrons are entitled to better service. The Commission will authorize certain increases in water rates, with a distinct understanding that service conditions must be improved in the immediate future. If petitioner fails in its duty to its consumers, the Commission will entertain a petition to reconsider its present findings and reserves the right to initiate proceedings to annul the water rates herein authorized."

In its Cause No. 6229 the Commission on the petition of certain consumers reduced rates because of inadequate service. Omitting the name of the city and the utility, the Commission in that Cause said:

"If the gas service at———was adequate, the Commission would have no choice, under the law, but to deny this petition and continue in effect the present rates.

"Section 7 of the Public Service Commission Act provides: 'Every public utility is required to furnish reasonably adequate service and facilities. The charge made by any public utility for any service rendered or to be rendered, either directly or in connection therewith, shall be reasonable and just, and every unjust or unreasonable charge for such service is prohibited and declared unlawful.' A public utility is entitled to earn its proper operating expenses, including taxes and depreciation and a reasonable return on the fair value of its property, if it furnishes reasonably adequate service. The evidence in this case shows, and at the hearing respondents admitted, that the gas service in ——— is inadequate. Petitioners submitted the testimony of a large number of witnesses whose residences were distributed over the city, so that practically every section of the city was represented * * * * * * the Company frankly conceded that its service was not adequate and admitted the correctness of the complaints of the witnesses who did testify. The evidence does indicate beyond a doubt that the gas service at ——— has been inadequate for at least a year and perhaps for several years, and that it is now inadequate."

"The ——— Company has a monopoly of the gas business at ———. It purchased the plant and business and entered the territory knowing the law required adequate service at reasonable rates; it has on its own initiative assumed the burden

and responsibility of operating a gas utility at ——— in accordance with the requirements of the law and it has assumed the burden of furnishing adequate equipment and facilities properly installed. It has assumed the burden of furnishing competent and efficient management. The owners of this utility have no reason or right to expect that they ever will be permitted to earn a reasonable return on the value of their gas property at ———, unless and until they do their duty to the public and furnish the character of service which the consumers have a right to expect and demand."

In its Cause No. 5286, which arose upon the petition of a telephone company for an increase in rates, the Indiana Commission employed the following language:

"The Commission believe that the term 'adequate service' extends beyond mere mechanical service—the ability in case of a telephone utility, quickly and accurately to obtain the number called. It includes also a proper attitude on the part of the utility towards the public. The Commission believes that a utility intrenched behind a bad financial showing can not demand increased rates as a matter of right, regardless of its service to the public and its relations with the public * * * * . The Commission believes that rates should not be increased until service is made reasonably adequate—directly by increased mechanical efficiency and indirectly by a better attitude toward the public."

From the foregoing excerpts from decisions of the Indiana Commission it will be noted that that Commission fully endorses the view that the character of service rendered by a utility should be taken into consideration as an important element in constructing rates.

Indeed it is difficult to conceive of a proper rate structure which does not take into consideration the character of the service given. I have heard counsel for utilities contend that service is not an element in rate-making, but it strikes me that this contention is capable of being reduced to an absurdity. Let us assume, for example, that there are two cities or towns of precisely the same population, topography, area, climate and abundance of water supply. In city "A" a water company is operating and the value of its plant is $100,000. In city "B" another company is operating and the value of its plant is also $100,000. Operating expenses are practically identical, but in "A" the water service is indaequate, frequent break-downs occurring due to carelessness and inefficiency; domestic and fire pressure varying and not adequate. In "B", on the contrary, the service is excellent and adequate pressure is maintained at all times. Would it not be an absurdity to cause the water consumers in "A" to pay for their inadequate service as high a rate as the water consumers in "B" pay for their splendid service? To make the same rate in both of these cities would be to place a premium on negligence and inefficiency and to penalize the consumers who must pay an adequate rate for inadequate service.

Of course no two cities are identical in size and conditions, but they vary in degree only and what is true in the hypothetical case in true in reality.

The foregoing reasoning is only applicable where a monopoly exists. In cities and towns where there are competitive utilities competition will take care of differences in service and the utility whose service is bad will soon find that all its customers have gone over to its competitor. This is about the only advantage that I can think of that can ever accrue from a competitive utility situation, and that is entirely obviated where rates are properly constructed, taking the nature and adequacy of the service into consideration as an important element.

To permit a utility to lower its standard of service is to permit the utility to increase its rates. When a rate is fixed a certain standard of service exists, and if that standard is subsequently lowered there results automatically an increase in rates because the utility is giving less for the authorized rate than was contemplated at the time that the rate was granted.

It seems too that a sound public policy would dictate recognition of the rule that the character of service should be taken into consideration in fixing rates because there should be a premium on good service, or to state the matter inversely, there should be a penalty for poor service.

Let me in conclusion deviate for a few moments to speak of public relations as an element of service. In one of the decisions of the Indiana Commission quoted in this paper, unsatisfactory public relations were coupled with inadequate service as grounds for refusing an increase in rates. My observation and such little experience as I have had convince me that no service, however adequate from a mechanical or technical standpoint, can be acceptable and satisfactory to the public

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served unless the relations between the public and the utility are such that there is courtesy and forbearance on the one hand, and confidence and forbearance on the other. Most utilities are corporations and most of them have a monopoly within their territory. The public, because of an indiscriminate damning of corporations and monoplies generally by a certain type of public speaker, and a particular species of periodical, have come to look askance upon any organization to which those two terms can be applied. It is yours to remove this false impression; to show by practical demonstration that a properly regulated monopoly is the ideal situation in the utility field and that a corporation can be as courteous and as conciliatory as an individual. Friendly relations between the public and the utilities are for these reasons as greatly to be desired as the giving of superlative service and if the Public Service Commission in the administration of its duties can aid in the slightest toward bringing about such proper public relations, it's work in that respect will do more toward solving present day utility problems than any other work to which it can set its hands.

The foregoing paper by Mr. Wilde was presented at the 1922 annual convention of the Indiana Sanitary and Water Supply Association.

"BUY MUNICIPALS NOW," SAYS BABSON

(Editor's Note:—Roger W. Babson, the well-known authority on financial affairs, discusses investment opportunities in the public works field in the present article.)

The past few years have been hard for cities and towns desiring to borrow money. During the war a ban was placed upon municipal borrowing and unnecessary public building. Directly after the war money was scarce and rates were high. It has only been within the last few months that cities and towns have been able to secure what money they have desired at a fair rate. Municipal fathers, contractors and investors are now wondering whether the present decline in rates is temporary or will extend over several years.

Study of the situation leads me to believe that the present decline in interest rates will continue and that cities and towns will be able to borrow freely during the next few years. It even looks as if city fathers will soon be solicited by bond houses for issues to sell. Up to the present time city officials have been obliged to hunt up banks to buy their securities. The time will soon come when the bankers will be sending buyers throughout the country to hunt up bond issues that they can sell. We have had years of advancing interest rates and we will have years of declining interest rates.

In addition to the law of business cycles, the tax situation is very much in favor of municipal borrowing. Before the days of income taxes and surtaxes, bonds of our best cities sold on a 3½ per cent basis, and even better. Now, when wealthy men are obliged to pay surtaxes of from 30 per cent to 50 per cent these tax exempt bonds of cities and towns should be in great demand. Some of my associates even state that many of these bonds may go up until they are on a 2½ per cent basis, or less. Of course, this also applies to the Government bonds, although the Government bonds are rather short time and therefore not so attractive to the investor. Cities and towns will temporarily be greatly benefited in their borrowing by any amendment to the Constitution making all bonds taxable. If such a legislation is attempted, there naturally will be a lot of tax exempt bonds put on the market just preceding such legislation. Some feel that such a flood of securities would depress the price, but others believe that if they are to be the last of tax exempt securities, the market will absorb easily all they offer. Whichever is the case, cities and towns will have no difficulty in disposing of their securities during the next few years, and the interest rates should steadily and continually decline.

This means that municipalities should immediately adopt civic planning schemes and probably should make during the next five years such improvements as they ordinarily would in ten. The time to make hay is while the sun shines, and the time to borrow money on long term loans is when money rates are low. Hence, cities and towns should not only borrow during the next few years for their current needs, but should borrow large sums and invest the same for use for years to come, especially during the next period of unemployment."

If cities operated on a business basis, they would borrow their money at times like the present, stow it away, and then spend it when the next period of unemployment comes. By spending it at such times, they not only could get the work

done very much cheaper, but they could perform a distinct service to the people of the community. The general custom followed is the reverse. Cities now do their construction work when it is easy to get money, which is when labor is fully employed and when everyone else is building. This is all wrong. When the period of unemployment comes it is very difficult to borrow money for construction work because money is then tight and the citizens feel poor. Hence, under the present system it is impossible to do much to relieve unemployment when it comes. If an ice man attempted to follow the same system in his business as the city officials follow, he would wait until summer to cut his ice!

For investors this means that tax exempt securities and town bonds should now be purchased even though they have already gone up some in price. When buying tax exempt issues seek the long term ones as these will show the greatest profit. A great deal of public work will be done during the next few years. City water plants will be extended, more sewers will be constructed, new public buildings will be erected and the good road movement will continue to grow.

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In cast iron rust never penetrates below the surface; the first layer of oxide which it forms acts as a protection, effectively preventing further corrosion. Should the tar coating placed on all water pipe become destroyed, the metal will, in this way, form its own coating.

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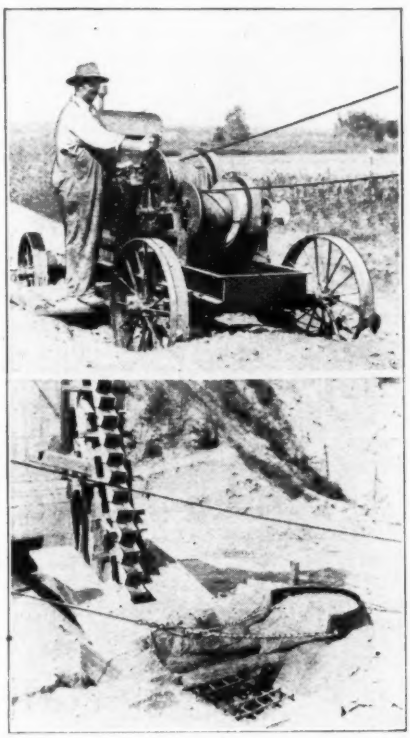
Construction News and Equipment

PORTABLE POWER DRAG SCRAPER OUTFITS

To meet the requirements of the man who is handling material in a small way, especially the county road commissioner or contractor who wishes to utilize a local sand and gravel deposit, a new type of portable power drag scraper outfit has been placed on the market by Sauerman Bros., 1142 Monadnock Bldg., Chicago.



SAUERMAN PORTABLE DRAG SCRAPER OUTFIT.

Top View Shows Gasoline Engine Driven Power Unit. Lower View Shows Scraper Delivering Sand and Gravel to Boot of Bucket Elevator of Small Screening Plant.

The new outfits are equipped with "Crescent" type power scrapers, which are especially suited for use with a light power unit as they are easy to pull and travel straight. The doube drum hoist is furnished with gasoline engine direct connected, or is arranged for belt drive from tractor or other motive power. The truck frame is of heavy steel channel construction mounted on broad tread, grooved steel wheels with steel axles.

Any laborer on the job can operate a Sauerman portable scraper outfit. One man handles the entire operation through two levers placed side by side. There is nothing for another man to do, for the scraper just has to be dragged back and forth, loading and dumping being accomplished automatically at the will of the operator. The front drum of the hoist operates the "load" cable which leads through a sheave from the drum to the bridle chains on the front of the scraper. The "pull-back" cable leads from the rear drum through another sheave out to a guide block at the far end of the excavation, and then is attached to the rear bridle chains of the scraper.

The entire outfit can be made ready to move in a jiffy and in less than an hour after arriving at new location it can be in operation. In moving from one set-up to another, simply wind the cables on the drums, disconnect the bridle cable, put the scraper and blocks on the truck, hook on the tractor, motor truck or team, and pull out. At new location sink the wheels of the power unit into the ground, connect bridle cable to new stakes or deadmen, locate guide blocks, haul out the cables, hook onto scraper bucket, turn over the engine and go.

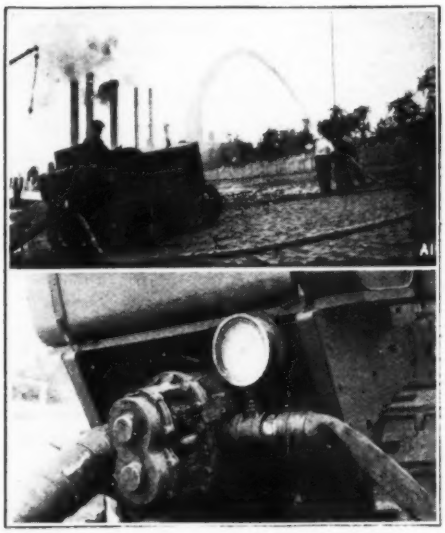
These little outfits are modest in price, yet embody the same quality features of design and construction that are found in the large Sauerman power scraper and dragline cableway excavator equipment.

ROTARY PUMP ATTACHMENT FOR 5-TON "CATERPILLAR" TRACTOR

A very practical accessory in the form of a rotary pump which can be readily attached to the standard 5-ton "Caterpillar" tractor is now being offered to the trade by the Holt Manufacturing Co., Peoria, Ill. The pump is of special design, compact in size, and is attached to the

rear of the tractor in exactly the same position as the power pulley attachment. It is driven direct through the countershaft from the motor and is capable of delivering 220 gals. of water per minute under working pressure of 100 lbs. per sq. in. At normal speed of 1,000 R.P.M. it throws a 1⅛-in. stream 100 ft. in the air and requires but 26 h.p., which is only approximately two-thirds of the normal motor capacity of the 5-ton "Caterpillar." There is accordingly a large reserve for overloading, should the pump be called upon for extra heavy duty.

This reserve capacity enables the use of a long hose both for intake and discharge. Where an ordinary length of hose is employed a very broad area can be quickly drenched with a very heavy stream. One special field of usefulness is in patrol work in state forests, in the timber districts, etc. The "Caterpillar," of course, has the power and the capacity



VIEWS OF ROTARY ATTACHMENT FOR 5-TON "CATERPILLAR" TRACTOR.

to travel over all sorts of ground, is able to penetrate to points inaccessible to other machines or vehicles, and is able to travel at an active speed. Where a stream or other water supply is available the "Caterpillar" with pump attachment can render vitally important service in forestry work.

Another interesting use for this pump is in municipal fire service. Many cities and towns employ "Carterpillar" Tractors for road building and maintenance in the summer and for snow removal in the winter. By means of the pump attachment the "Caterpillar" is always ready for emergency use in case of fire. A hose reel cart can be quickly transported from the central station to the fire, the intake hose placed in any convenient well, cistern, tank or stream, and a flow of water is instantly available equal to that of any of the usual type fire engines. For pumping out cellars in flooded conditions, as an auxiliary for irrigation work, for use by contractors in pumping out excavations, trenches or cofferdams, this pump is convenient and practical not only for its capacity, but because it can be quickly placed at any desired point.

In general design this pump is of the rotary gear wheel type, with all working parts mounted in a heavy cast iron case which preserves perfect alignment. The two main shafts are geared together at the outer ends and carried in Hess-Bright anti-friction ball bearings. The gears are of special alloy steel, machine cut, ground and heat treated. The stuffing boxes are quickly accessible and easily repacked. A positive jaw clutch connects and disconnects the power to the pump in the same manner as the power pulley would be controlled. The efficiency of the pump is increased by the fact the pump gears are driven through the closely fitted spur gears at the extreme rear. These latter gears are enclosed in a tight case and run in a bath of oil. The entire driving load of the pump is taken by the spur gears so that in this way none of the metal to metal contact comes on the pump blades. In addition to the ample lubrication for the drive gears, compression cups are provided for the main ball bearings. While this pump is built extra strong for heavy duty service it is light in weight, weighing only 225 lbs.

This new rotary pump has been developed through the co-operation of Holt enginners and the Goulds Manufacturing Company, Seneca Falls, New York, and has been tested and proved dependable under many different field conditions.

As this pump can be readily attached to any new 5-ton "Caterpillar" tractor or any of the 5-ton tractors already in the field, the Holt Manufacturing Company anticipates and active demand for this pump, as its field of usefulness is practically unlimited.

TAR AND ASPHALT MAINTENANCE HEATER

The Littleford Midget No. 69, here illustrated is made similar to the regular heater of this type, except that it is smaller and built of lighter material. It is more adaptable to road maintenance work, as it is more convenient to move about and can be handled by one man.

State Highway Departments, County Road Commissioners, and Municipalities are using this particular heater for patrol work with great success.

NEW TYPE (LITTLEFORD MIDGET NO. 69) TAR AND ASPHALT HEATER.

The capacity of the kettle of the No. 69 Midget is 25 gals., which is sufficient for the average patrol work. A convenient drain is provided at the rear where the valve is kept warm because of its close proximity to the fire box.

The construction of this heater is exceptionally durable. The large fire box is fitted with renewable cast iron grates and the furnace shell is protected by liners of fire box steel. The rectangular kettle is removable. Seams are heavily welded, thus eliminating all possibilities of leaks and possible danger of fire. Removable cover is provided.

The No. 69 Midget is mounted on two all steel wheels of 18-in. diameter with 2x⅜-in flat tires. The axle is 1¼-in. diameter. A rugged handle, well braced and fitted with stiff leg is attached to front end at a convenient height for drawing the heater about.

NEW TROWELLER FINISHER ON AUSTIN CONCRETE TAMPER

The perfect finish of a well plastered wall is what the new Troweller Finisher on the Austin Concrete Tamper mechanically duplicates. Hand trowelling has always been unsatisfactory and expensive, due to the width of the road. The Austin Troweller, however, overcomes all difficulties incident to the old method, takes advantage of every good point and, in addition, follows the crown perfectly.

The carriage, accurately made and fitting the adjustable profile bar, a templet of the exact crown of road required, travels across the road with a razor-stropping motion, at speed greater than that of hand trowelling. Two steel adjustable plows, one on each side of the 24-in. trowel proper, press down and work the surplus material. Easily controlled by two levers, a vertical lift is provided for the profile bar, and the stroke is made adjustable, so that it is possible either to trowel the full width of the road or work at any particular spot. At the back of the carriage is a mechanism which slightly tilts the trowel up in the direction of travel.

The net result of the Troweller is to provide in the final finish a perfectly contoured road, swept by a trowel guided with mechanical accuracy for its entire srtoke by a profile bar. No more dependence upon the human eye or effort

to maintain a faultless grade. Furthermore, it provides a means for resurfacing any spots that may from any cause be disturbed by lack of sufficient concrete, footprints or foreign material.

A NEW PIPE WRENCH

The "Little Giant" pipe wrench, a new wrench with several interesting improvements, has just been put on the market. The wrench has the "end opening" feature which is familiar to users of machinists' wrenches. Its application to pipe turning can readily be seen by a glance at the accompanying cut.

The advantage of this wrench over the conventional style is the ease with which it can handle pipes in corners, close to walls, and similar confined places. The person using it can set it straight on the pipe as he would a pair of pliers, instead

THE "LITTLE GIANT" PIPE WRENCH.

of having to fit the jaws on from the side.

The wrench has only three parts—a handle and jaw in one piece, which is drop forged and heat treated; a movable jaw, likewise drop forged and heat treated, and a hardened steel nut. There are no springs, rivets, frame or pins, all these parts being eliminated. In spite of the absence of springs the wrench takes hold and releases instantly at the option of the user.

The new wrench has been designed for maximum strength. The 14-in. size has repeatedly withstood stresses in excess of 4,700 inch pounds without slipping or bending. Readers familiar with government requirements will recall that the army and navy departments require a test of 2,800 inch pounds for a wrench of this size. Yet owing to the elimination of extra parts the "Little Giant," in spite of its extra strength, weighs less than a Stillson type wrench of corresponding capacity.

Another feature is the double set of teeth on the main jaw. The movable jaw can be engaged at the option of the operator with either of these sets of teeth with consequent lengthened life. On the large sizes, 14 in. and greater, two additional sets of teeth are provided, making four in all, and the movable jaw can be reversed to engage these additional sets of teeth, which are below the adjusting nut. This is very useful in connection with certain classes of work, besides practically quadrupling the life of the tool. The wrench is being manufactured in 8, 10, 14, 18 and 24-in. sizes, of which the three smaller sizes are already on the market. The new wrench is a product of the Greenfield Tap and Die Corporation, Greenfield, Mass.

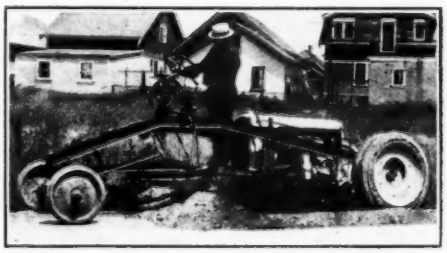
A ONE-MAN ROAD GRADER

The Wehr one-man power grader is designed to meet the requirements for city street and county road maintenance work, also finishing work and light grading for the contractor.

The machine is heavily constructed, utilizing the Fordson tractor as its power unit, which enables the user to get quick service on any motor parts in any part of the country.

The grader is constructed of heavy steel channel frame and is put out with either a 6-ft. or 8-ft. blade. The 6-ft. blade is for finishing work and grading and the 8-ft. blade for maintenance work. The blade can be raised or lowered and tilted at any angle desired by the operator.

The tractor is simply controlled by the operator and can be handled as quickly and as readily, as by the operator on the tractor seat.



VIEW OF WEHR ONE-MAN ROAD GRADER DRIVEN BY FORDSON TRACTOR.

The motor is swung on a three-point suspension so that no unnecessary strains are put on the power unit. This construction enables the full application of the power unit direct to the cutting blade, utilizing the weight of the power unit to hold the grader steady on the road when working. For this reason this machine will do considerable more than any

other light type machine on the market, where the power is utilized ahead of the cutting blade.

Scarifier arrangements will be furnished as regular equipment and screws which operate the raising and lowering of the blade, will operate the scarifier also.

The standard Fordson tractor wheels can be utilized, but any rubber tire wheel equipment can be utilized for highway or city street maintenance work. The wheels shown in the photograph weigh 1,400 lbs., and are rubber cushion, and will secure all the traction that the motor can handle.

For sub-grading or maintaining city streets or county highways, this machine has some special advantages, as it is the only machine for this type of work which enables the operator to screw the blade down, also weight enough to hold the blade in hard roads.

This combination makes a very low priced economical maintainer which will do three times the work of any horse-drawn equipment.

ST. PAUL ADOPTS ZONING ORDINANCE

By George H. Herrold, City Planning Engineer, City Hall, St. Paul, Minn.

The City Council of St. Paul, Minn., passed a zoning ordinance, Friday, July 7th. The ordinance was prepared by the City Planning Board, George H. Herrold, City Planning Engineer, and Ed. H. Bennett and Wm. E. Parsons, Chicago, Ill., Consultants.

The ordinance provides for six Use Districts and four Height Districts, areas are made to conform to the uses all shown on one zoning map. The residential areas are divided into A, B and C residence districts. There is also provided a Commercial District, a Light Industry District and a Heavy Industry District.

The material difference between A and B residence districts is that the area required per family is greater in the A district. Apartment houses are not permitted in either A or B residence districts, but are permitted in the C district. There are special provisions in the ordinance relating to: 1, the grouping of institutional buildings in order to preserve the residential character in the A and B residence districts; 2, the construction of public garages which are not permitted in the A, B and C districts; 3, the establishment of set back lines in the residential districts, and 4, the requiring the stores to take the same set back as the residence where they are permitted at certain corners in the residential areas.

There are four height districts: 40, 75, 100 and 150 ft. The original ordinance called for a height limit of 120 ft. in the downtown business district but this was amended to 150 ft. by the Council. There are provisions in each for increasing the height above given by setting back 1 ft. in height for each ft. the building is set back in the 40-ft. district; 2½ ft. in height for each ft. building is set back in the 75-ft. district; 3 1-3-ft. in height for each ft. building is set back in the 100-ft. district and 4-ft. in height for each ft. building is set back in the 150-ft. district.

The zoning ordinance was authorized by the State Legislature, Chapter 217 Session Laws of 1921. It provides for zoning under the police power. A Board of Zoning is established, consisting of five members of the Planning Board and the City Architect. Provisions are made for amending the ordinance upon petition of 50 per cent of the owners of the frontage after review by the Board of Zoning and a two-thirds vote on the part of the Council.

The ordinance was first presented to the Council on April 26th. On the date of the third reading, May 23rd, at which time the ordinance must be approved as to form or postponed, the St. Paul Real Estate Board appeared before the Council and asked for six months' time to review the ordinance—this was refused; they then asked for 30 days which was granted. The report of the St. Paul Real Estate Board submitted to the Council June 30th recommended that all car lines be zoned for business, other changes asked for were minor, representing small changes in boundary lines, increasing the area in which apartments might be built and business go in.

There was considerable argument over the question of throwing residential areas along car lines into a business district, but this was finally accepted, incorporated in the ordinance and passed as to form on the date named June 30th, and finally passed July 7, 1922.

The field work on the St. Paul zoning ordinance began in May, 1921. A complete field survey was made to determine the use of every piece of property in the city, and these uses were noted by symbols on a new map of the city prepared by the City Planning Board on the scale of 500 ft. to the inch. Set-backs, height

of buildings, etc., were also determined by the survey. Upon this was built up the zoning map.

It is of interest to note that no public hearings were held on this ordinance, although considerable publicity work was done by presenting the general principles of zoning to all clubs and civic organizations and through the newspapers, and in some cases exhibiting the tentative zone plan. All newspapers of the city backed the zoning ordinance and the City Planning Board to the limit.

The ordinance required four readings before the Council, and on these dates which were published, objectors appeared, but these were not many. It was the viewpoint of the City Planning Board and of the Council that public hearings would develop individual opposition only, and that as a zoning ordinance was for the good of the greater number and being done under the police power that individual objectors should not influence the plan.

Ample provision, however, was made in the ordinance to permit those who felt aggrieved to present evidence and petitions to have the ordinance amended after its passage.

St. Paul has a population of 240,000 and an area of 55.4 sq. miles. We have no congested areas and no tenement districts. The most congested area, one-quarter square mile in the old residential district to the west of the State Capitol Building is 40,000 per sq. mile. The existing area for each purpose and as zoned is shown in the following table.

	Present area in sq. mi.	As zoned area in sq. mi.
Residential	17.20	31.05
Business	.9	1.78
Industrial & R. R. Land	3.8	12.10
Miscellaneous, Parks, Cemeteries, Rivers, Lakes, etc.	6.52	6.62
		Unassigned
Vacant	27.08	3.85
	55.4	55.4

U. S. ROADS BUREAU COMPILES HIGHWAY COSTS

Average costs per square yard of various types of paving for country roads have been compiled by the Bureau of Public Roads, United States Department of Agriculture. The figures cover 68,000,000 sq. yds. of paving constructed with Federal aid in all parts of the United States during the period 1916-1921. The costs per square yard are as follows: Sand-clay, 18 cts.; gravel, 46 cts.; plain and surface-treated macadam, 95 cts.; bituminous macadam, $2.10; bituminous concrete, $2.50; plain cement concrete, $2.57; reinforced-cement concrete, $2.74, and brick, $4.10. These figures cover only the cost of the paving; they do not include the cost of grading.

A total of 28,135 miles of road have been built with government aid since July 1, 1916, when the congressional act under which the Federal government was authorized to aid the states in road building went into effect. The total estimated cost of these roads has been $496,151,683.43. Of this amount Federal aid comprised $211,135,376.31.

The average cost per mile of road construction during the five-year period runs from $8,115 per mile for graded and drained roads, to $39,540 per mile for concrete, and $49,570 for brick roads. The average cost of all roads, including graded and drained, sand clay, gravel, macadam (waterbound), macadam (bituminous), bituminous concrete, concrete and brick roads, was $17,630. Federal aid was at the average rate of $7,500 per mile.

SOUTHERN STATES HAVE BIG ROAD PROGRAMS

In road building and street paving work the southern states are showing greater activity than at any time in their history. Contracts reported during the past four months aggregate in value about $40,000,000. Every state in the South is showing tremendous progress, especially in road improvement. Contracts awarded in the last four months include, in value, the following: Alabama, $1,870,000; Arkansas, $842,000; Florida, $4,800,000; Georgia, $780,000; Kentucky, $870,000; Louisiana, $932,000; Maryland, $966,000; Mississippi, $844,000; Missouri, $2,735,000; North Carolina, $7,780,000; Oklahoma, $1,975,000; South Carolina, $1,104,000; Tennessee, $833,000; Texas, $6,657,000; Virginia, $690,000; West Virginia, $4,523,000. In addition to the actual contracts awarded, there is a tremendous volume of highway improvements for which plans are being made and for which bids will be received during the year.

Contracts Awarded

ROADS AND STREETS

Ariz., Phoenix—Pacific Constr. Co., Phoenix, awarded contr. for paving East Sect. Mesa Hwy., 5 miles in length. Contractor bid $12,923 in bitulithic pavement on bitum. base course and $13,030 on altern. No. 3 which calls for asph. conc. surf. course on bitum. base course; White & Miller, Phoenix, awarded contract for 5 miles impvt. on Bisbee-Tombstone Hwy., at $51,744 for 52,800 sq. yds. asph. conc. surfacing. Warren Bros., Phoenix, awarded contract for Flagstaff paving at $25,381, including 10% for engrg. and contingencies. Ben Pearce, Phoenix, awarded contract for impvt. of Nogales-Willows Hwy., at $65,536.

Ark., Mena—Western Constr. Co., Little Rock, awarded contr. for 15 miles hard surf. road on Talihint Hwy. bet. Mena and Okla. state line, at $124,520.

Cal., Bakersfield—Kneen & Austin, Dudley Blk., Santa Monica, award. contract for paving D, E, G, K, L, N and P Sts., in Dist. 77, at $174,538. Warrenite-Bitulithic in Dist. 77; 3½-in. asph. conc. base.

Cal. Sacramento—Pacific Constr. Co., San Francisco, award. contract for constr. of 16.53 miles state hwy., Humboldt Co., at $439,211.

Cal., Sacramento—Kaiser Paving Co., Oakland, awarded contr. for constr. of 10.7 miles state hwy. in Siskiyou Co. bet. Upton and Shasta River, at $163,934.

Cal., Sacramento—Geo. H. Oswald, 366 E. 58th St., Los Angeles, awarded contr. for constr. of 8.77 mi. state hwy. in Orange Co., at $126,615.

Cal., Sacramento—Southwest Paving Co., 415 Washington Bldg., Los Angeles, awarded contract for constr. of 10.3 miles state highway in Santa Barbara Co. bet. Cana de Los Llagas and Los Chiqueros Crk. with asph. conc. wearing surface, at $103,705.

Cal., Sacramento—Pacific Constr. Co., Oakland, awarded contr. for constructing 8.5 miles state hwy., Merced Co., at $125,586. Blanco & Taylor, Vallejo, awarded contr. for constructing 12.2 miles state hwy., Merced Co. bet. San. Luis Crk. and Los Banos, at $216,550.

Cal., San Bernardino—H. H. Lienau awarded contr. for paving Hellman Ave. (R. D. I No. 17), at $108,000.

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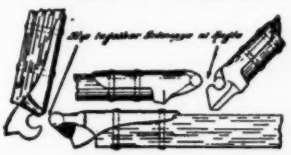

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Fla., Green Cove Springs—T. B. Gillespie, Palatka, awarded contr. for 60,000 sq. yds. brick paving; $115,000 bonds available.

Fla., Ocala—Florida Asphalt Block Paving Co., Tampa, Fla., awarded contract for 55,000 sq. yds. paving at $100,000.

Fla., Winter Haven—Stidham & Hughes, Lake Wales, Fla., awarded contr. for 127,000 sq. yds. street paving, necessary curb, gutter & draing.; asph. conc. on limestone base, at $300,000.

Ill., Chicago—White Constr. Co., 17 N. LaSalle

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K TRADE MARK

St., awarded contr. by Bd. Local Impvts., City Hall, for grading, paving and bldg. sewers in Blaine Pl. N. Francisco, N. California Aves., N. Mozart, Argyle and Ainslee Sts., at $200,000.

Ill., Springfield—Milburn Bros. awarded contr. for laying 5.03 mile stretch of hard rd. thru sect. 16, Winnebago Co., at $104,476.

Ill., Springfield—Cameron-Joyce, Smith-Elder Co. awarded contract for 17 miles hard rd. on Route No. 4, known as Illinois Blvd.—bet. Bloomington & Logan Co. line, at $368,353; also contr. for 3-mi. sect. hard rd. on Corn Belt trail in Woodford Co. and 5-mi. sect. of Corn Belt Trail in Woodford Co. went to Keokuk Quarry Co.

Ind., Mich. City—Municipal Paving & Supply Co., Michigan City, Ind., awarded contract for constr. of 4½ miles of the continuation of the Dunes Hwy. east of here. Road will be of conc., 20 ft. wide. Contr. price abt. $90,000.

Ind., Indianapolis—Hays Constr. Co., Indianapolis, awarded contrs. for approx. 39 miles paving, at $121,068 (5 projs.). The Barrett Co., Chicago, awarded contracts for approx. 30 miles, including constr. of 7.2 mi. of hwy. from Jeffersonville no. on Hamburg Pike, 1 mi. New Albany connectg. rd. Albert W. Karsteter, Lawrenceburg, received 1 contract for 10.1 miles constr., at $32,253.

Ky., Ashland—Sam L. Steele, Ashland, awarded contr. to pave sts. and alleys in So. Ashland and Normal City; brick and bitum. macadam, at $240,000.

Ky., Frankfort—Following contracts let by State Hwy. Comn.: Laurel Co., grade & drain 5½ miles, London-Mt. Vernon Rd., to E. A. Wilson, Knoxville, at $16,974; Caldwell Co., grade & drain 14 mi., Princeton-Marion Rd. to Costello Bros., Knoxville, at $57,211; Harlan Co., grade & drain 5.9 mi. Harlan-Pineville Rd., to Dempster Construction Co., Knoxville, at $93,818; Barren Co., rock asph. on 7 mi. so. of Glasgow to Geo. M. Eady Co., Louisville, at $198,098; Estill Co., waterbound macadam surf. treated on 4.1 mi. Irvine-Richmond Rd., to Conley Constr. Co., Somerset Co., at $69,841; Christian Co., rock asph. on 1 mi. from Hopkinsville to Western St. Hosp. to N. E. Stone, Madisonville, at $37,450. Maint. contracts as follows: Bell Co., surf. treatg. 12 mi. Pineville-Middleboro Rd. and 1 mi. Middlesboro-Cumberland gap rd., to Southern Oil & Tar Co., Louisville, at $9,361 for tar; Nicholas Co., surf. treating with light tar & heavy oil 4 mi. on Carlisle-Owingsville & Lexington-Maysville pikes, to R. B. Tyler Co., Louisville, at $7,228; Shelby-Co. surf. treating with medium oil 5.25 mi. Shelbyville-Eminence pike to R. B. Tyler Co., at $2,859; Cumberland Co., crowning, shaping & graveling 7.52 miles, Burksville-Edmonson Rd., to Alexander & Beck, Harrodsburg, at $16,780; Todd Co. surf. treating with medium oil 4.34 mi. Elkton-Hopkinsville Rd., to R. B. Tyler Co., at $3,215; Jefferson Co. surf. treatg. with tar 14.4 mi. Louisville-Taylorville pike, to Southern Oil & Tar Co., at $10,666; Bourbon Co. surf. treatg. with medium oil 12 mi. Paris-Mt. Sterling pike, R. S. Tyler Co., $6,432.

Ky., Louisville—Henry Bickel Co. and Louisville Asphalt Co. awarded contract at about $200,000 to pave between 2 and 3 miles of streets.

La., Springfield—L. A. Loustalot, Franklin, La., awarded contr. to gravel surface 17.8 miles Hammand-Baton Rouge Hwy., Secs. A & B, Livingston Parish, at $139,813.

Me., Augusta—Contracts awarded by state highway commission: Town of New Gloucester, 4.66 mi. cem. conc. to Jos. McCormick, E. Providence, R. I., at $191,120; Town of Wilton, 0.35 mi. gravel to Jas. H. Kerr, Rumford, at $17,538; Island Falls, 0.32 mi. gravel, Murtagh Hughes, Bangor, at $8,236, Easton, 3.14 to M. Hughes at $47,228; Orono, proj. 43, 2.19 mi. cem. conc. A. D. Bridges & Sons, Inc., Hazardville, Ct., at $57,326; Orono, Proj. 53, 1.76 mi. cem. conc. to Hassam Paving Co., Worcester, Mass., at $50,717; Canton, proj. 32, 5.023 mi. gravel to Jas. H. Kerr, Rumford, at $46,101; Canton, proj. 35, 3.443 mi. gravel to W. H. Doran, Mercer, $32,064.

Mass., Boston—Contr. for paving 19,430 ft. state hwy. Haverhill & Merrimac, conc., to Rowe Constr. Co., Malden, at $189,082; 20,000 ft. in Cummington & Goshen, bitum. macad. to T. J. Quinn, Ashton, R. I., at $221,052; 7815 ft. in Windsor and Cummington to Hanscom Constr. Co., 70 Kilby St., Boston, at $119,803; 3250 ft. in Burlington, gravel and light oil to A. J. Mitchell, Inc., R. F. D. Cohasset, at $4,936.

Mass., Boston—State Hwy. Dept., let contr. for paving 18,950 ft. state hwy. in Windsor & Dalton —bitum. macadam—to Lane Constr. Co., 37 Colony St., Meriden, Ct., at $161,958; 13,700 ft., in Lee, rein. conc., to C. E. Horne, Milford, at $143,139; 5580 ft. in Middleton, bitum. macadam, to J. E. Watkins, 1 Fern Ave., Amesbury, at $29,397.

Mich., Benton Harbor—Northern Constr. Co., awarded contr. for repairing entire length of Ship St.,—Lake Blvd., to Wayne St.—at $224,855.

Mich., Jackson—Brooks Constr. Co. awarded contract for 3 miles sheet asph. from Jackson city limits east to paved rd. thru Washtenaw and Wayne Cos. to Detroit, at approx. $100,000.

Minn., Mankato—Schruth & Welsh, 704 1st Natl.-Soo Line Bldg., Minneapolis, awarded contract for street paving at $132,000. W. Front, W. 4th, Warren, Byron and Liberty Sts.; will be brick on conc. base; Grove St. conc. All alleys conc. of Cl. B rock.

Miss., Heidelberg—United Construction Co., Hattiesburg, Miss., award. contract by Jasper Co. Bd. of Supvrs., for 15 miles Miss. Valley Hwy. thru county, at $120,000.

Mo., Fredericktown—Dick H. Hogan, Little Rock, awarded contr. to construct 16½ miles state hwy. betw. here and Coldwater, Mo., at $210,000.

Neb., Chadron—Roberts Constr. Co., 405 1st Natl. Bk. Bldg., Lincoln, awarded contract for Paving Dist. 3, at $117,378.

Neb., Omaha—National Constr. Co., Federal Reserve Bank Bldg., Omaha, awarded contract for paving 2nd St., and grading, at $85,070.

N. J., Belvidere—Crilly & Cannon Constr. Co., 4 Union Sq., Phillipsburg, awarded contract for constructing State Hwy. Route 9, Sec. 9, from Phillipsburg to Still Valley, at $110,345.

N. J., Morristown—J. S. Geigers Sons, 83 Hartford St., Newark, award. contract for reconstr. of 21,114 sq. yds. Speedwell Ave. from here to Morris Plains, conc., at $144,585.

N. J., Trenton—Rees-Taylor Co., Mechanics Bldg., awarded contr. for constr. of State Hwy. Route 1, Sec. 6, Greenwood Ave., at $95,347.

N. M., Raton—New Mexico Constr. Co., Albuquerque, awarded contr. for paving Dist. No. 9, with 5-in. crush. rock base and 2-in. bitulithic surf., on N. & S. 2nd Sts. Bal. of Dist. is to be paved with 4-in. crush. rock base with 2-in. bitulithic surface. Contr. price approx. $176,000.

N. M., Santa Fe—Following contracts let by State Hwy. Engr.: 13B, FAP, Valencia Co., 16.42 miles, to Peterson-Shirley & Gunther, Omaha, at $84,479; 20A, FAP, Lincoln Co., 2.79 mi. bet. Picacho & Border Hill to McCline & Dobson, Magdalena, at $35,965.

N. Y., Albany—Smith Bros. Constr. Co., Watertown, awarded contr. for Edwards-Fine Hwy., (about 10 miles long) at $353,405.

N. Y., Baldwinsville—Clarence A. Foote & Son, Mt. Morris, awarded contr. for construction of Jordan-Baldwinsville Rd., Part 2; also stretch in village of Baldwinsville, at $279,847. Rd. is 7.16 miles in length and will be of conc.

N. Y., Greenwood—Lee Dennison, Hornell, awarded contr. for impvt. of portion of Canisteo-Greenwood-Whitesville Rd., at $89,873. Wm. L. Collins, Greenwood, has contract for Rushford-Canadea Rd., 1.67 miles in length, at $23,483.

N. Y., St. George—Following contracts let by M. J. Cahill, Pres. Richmond Boro.: repaving roadway of Bradley Ave. to J. E. Donovan, 2205 Richmond Terrace, Pt. Richmond, $68,095; roadway of Bay St.—Thompson St. to tracks of Staten Isl. Rapid Transit R. R. and Richmond Terrace from York St. to Sailors' Snug Harbor Dock, to Brooklyn-Manhattan Contg. Co., 26 Court St., Brooklyn, at $270,378 and $266,573, respectively.

N. Y., Waterloo—The E. W. Foley Contg. Corp., Waterloo, awarded contract for constr. of Ovid-Interlaken Hwy., 6.4 mi. long, at $204,435.

N. C., Raleigh—W. F. McCanless, Charlotte, awarded contract for grading and paving 6.65 miles

Proj. 630-B, Gaston Co., 2-in. bitulithic on 5-in. conc., at $179,241.

N. D., Moorhead—W. E. Kennedy, Fargo, award. contracts for pavings on Front St., 1st Ave. No. and 11th St. So. Moorhead, at $102,784.

Ohio, Columbus—R. B. Sheridan, awarded contract to pave Parsons Ave. from Livingston Ave. to viaduct, at $134,383.

O., Columbus—T. D. Van Camp, Columbus, awarded contract for impvt. of Babbitt Rd., at $92,070; 4.16 miles 16-ft. waterbound macadam; E. D. Morris, Columbus, contr. for Walker Rd. approx. 5 miles at $93,447.

O., Findlay—Dorsey Constr. Co. awarded contract by County Comnrs. to improve N. Main St. with lake asph. at $125,109.

O., Lima—E. J. Heil, Lima, awarded contract for Lima-Wapakoneta Rd.; brick paving at $135,745.

Ore., Portland—Siems & Carlson, Spokane, awarded contract for grading and surfacing 17 miles forestry road in Whitman-National Forest Reserve bet. Austin and Prairie City, Grant Co., at $266,000.

Pa., Harrisburg—C. E. Walter, Butler, awarded contr. to build 13,917 ft. rd. on hwy. from Franklin to Kittanning at $131,445.

Pa., Harrisburg—Following contracts totaling $1,000,000, let by St. Hwy. Dept.: Cambria Co., Cambria Twp. 9,596 ft. to Lord Constr. Co., Hastings, at $74,818; Lawrence Co. R. 79, 27,081 ft. to Woods & Golder Constr. Co., New Castle, at $207,625; Clearfield Co., Irvona Boro., 7,118 ft. Gifford & Pritchard, Phillipsburg, $54,907; Indiana Co., White, Center & other Twps., 39,082 ft. to Torquato Bros. Co., Windber, at $296,376; Bradford Co. Troy & Columbia Twps., 11,158 ft. The Juaniata Co., Phila., at $89,949 and 25,082 ft. on Route 20, near Gillet, to Henry W. Horst Co., Rock Island, Ill., at $197.759; Jefferson Co. Sykeville & Winslow, 18,716 ft., Mason & Hangar Co., DuBois, at $164,622.

Pa., Pittsburgh—Booth & Flinn, Ltd., Pittsburgh, awarded contracts in Cambria Co. for 21,044 ft. rd. extending from Nanty Glo to Belsano, at $162,042; Jones Constr. Co., Salem, Ohio, award. contr. to build 6,067 ft. Parker City Boro to Armstrong Co., at $65,398; Booth & Flinn, Ltd., also awarded contracts in Indiana Co., at $205,237 for rd. in Greene, Grant and Montgomery Twps.; Torquato Bros. Co. Windber, awarded contr. for 27,632 ft. rd. Indiana Co., at $233,021.

Tenn., Knoxville—Jno. W. Flenniken, awarded contract for asph. paving and conc. curbing of streets in New Iberia, at abt. $150,000.

Tenn., Nashville—Y. Y. Phillips, Martin, Tenn., awarded contr. for 8.54 miles F.A.P. No. 54, at $284,000.

Tex., Breckenridge—Womack Constr. Co. award. contract to grade 21,500 cu. yds.; pave 86,000 sq. yds. with vert. fibre Warrenite bitulithic, Uvalde rock asph., etc., at $822,216.

Tex., Denison—Julian C. Fields & Co., Denison, awarded contr. for 4 mi. State Hwy. No. 19, 37,398 sq. yds. one course conc. pavement, FAP 296, at $93,876; 6 miles St. Hwy. No. 5, 56,320 sq. yds. one course conc. pavement, FAP 295, at $143,616—both in Lamar Co.

Tex., Georgetown—W. E. Dozier Co., Austin, awarded contract for paving about 7 miles Georgetown streets at $200,000.

Tex, Groveton—Smith Bros., Crockett, Tex., awarded contract for 17.4 mi. 16-ft. gravel rd. on St. Hwy. 19, Trinity Co. FAP 225, at $189,932.

Tex., Houston—Hayden & Austin, Houston, awarded contract for surfacing 13.2 miles Hwy. No. 36 near Rosenberg, at abt. $129,000. Specfs. call for base of 6 ins. shell & 4 ins. crushed limestone, topped with 1 in. of Tarvia with limestone filler.

Tex., Taylor—W. E. Dozier, Austin, awarded contract for paving in Georgetown, at $275,000.

Va., Richmond—State Hwy. Comn. let following contracts: 165, Route 9, 3.35 mi. one course conc. state rd. bet. Grove and Lee Hall, to S. R. Curtis & Sons, Lee Hall, Va., at $98,490; 179, Route 9, 7.99 mi. one course conc. state rd. bet. Williamsburg and Aoano, to J. U. Addenbrook's Sons, Norfolk, Va., at $230,455.

Wn, Seattle—Albertson, Cornell Bros. & Walsh, Tacoma, award. contract for paving with conc. Orillia-Kent Rd. along west side of White River valley, at $138,500. Contr. calls for 20-ft. conc. rd. 4.38 miles in length.

Wn., Seattle—Independent Asphalt Paving Co., Seaboard Bldg., awarded contract for paving Wilson Ave., at $133,467; Jno. Mattson, awarded contr. for paving W. Marginal Way, at $273,217; V. Ramaglia, awarded contr. for paving Hamlin St., at $3,560.

W. Va., Huntington—The J. M. Randich Co., Huntington, awarded contr. for constr. of 4.5 miles hard surf. rd. in Wyoming Co. bet. Mullens and Ellmore, at $194,630. Kingwood-Terra Alta Rd., Preston Co., awarded to Fidelity Constr. Co., also a half mile stretch in Mercer Co.

W. Va., Wheeling—P. J. Gilligan, Cass & Otto and H. L. Seabright, awarded contr. to pave streets with brick on concrete, at $300,000.

SEWERAGE AND SEWAGE TREATMENT

Cal., Long Beach—R. N. Nikcevich, P. O. Box 204, Long Beach, awarded contract for constr. of sewers in Redondo and other streets in Sewer Dist. No. 6, at $98,334.

Cal., Watts—Thompson & Packard, 1113 W. 40th Pl., Los Angeles, awarded contract to construct sewer sys. for City, at $498,000.

Cal., Watts—A. W. Phillips, 537 N. Hoover St., Los Angeles, and M. G. Brkich, 1506 Pleasant Ave., Los Angeles, awarded contracts for sewerawge system here at $442,775.

Ont., Atwood—G. Arbuckle, care G. Lockhead, Atwood, awarded contract for ditching, mostly excav. small amt. tile and conc. work, at $63,742.

D. C., Washington—B. C. Baker, Uniontown, Pa., awarded contr. for constr. of sewers in Brentwood Cottage City and adjacent territory in Prince Georges Co., at $54.573; also contract for sewers in Riverdale at $41,834.

Fla., Lake Worth—Bunker & Lockman, awarded contract to constr. new sewer system, at $89,713.

Ga., Atlanta—McDonald Constr. Co., Atlanta, awarded contr. for extendg. Lloyd St. sewer, at $124,650; extendg. Stewart Ave. trunk sewer to J. B. McCrary Co., 3rd Natl. Bk. Bldg., at $11,907; several small sewers in various streets to Dysard Constr. Co., Austell Bldg., Atlanta, at $27,182.

Ga., Lagrange—J. B. McCrary Co., Atlanta, Ga., awarded contr. for constr. of extension to sewer system at approx. $50,000.

Ky., Louisville—Henry Bickel Co., Louisville, awarded contr. for Bardstown Rd. sewer at about $65,000. J. H. Cahill, Louisville, award. contr. for 44th St. sewer, at approx. $40,000.

Ky., Paducah—E. R. Harding Co., 400 Robinson Bldg., Racine, award. contract for constr. of sewers, 96 and 102 in. rein. conc. monolithic, 42-72 in. clay segm. blk. 15-36 in. vit. clay pipe, at $508,000.

Minn., Brainerd—Riches & Son, Superior, Wis., awarded contr. for sewers, at $38,908.

Minn., St. Charles—Gedney & Murphy, 211 Lbr. Exch., Minneapolis, awarded contract for 35,621 lin. ft. 8 and 10 in., 81 manholes, 15 lampholes, disp. plant, at $64,405.

Neb., Emerson—W. B. Carter, U. B. Bldg., Sioux City, awarded contract for sewer and disposal plant, at $38,383.

N. J., Hackensack—A. Capone, Jersey City, awarded contract for 1st Ward sewer, at $266,879.

N. Y., Brighton—A. Petrossi, Rochester, award. contr. for sewers in Dist. 1, at $33,998.

N. Y., Syracuse—J. Young, Bastable Bldg., awarded contr. for sewage treat. plant, at $68,284.

N. C., Kernersville—Boyd, Higgins & Goforth, Charlotte, awarded contract for water, sewer and discharge system; tanks to R. D. Cob Mfg. Co., Union, Ga.; wells to Cummins & Williams, Kernersville. Total cost abt. $100,000.

O., Columbus—Gessner & Co., 616 Nicholas Bldg., Toledo, award. contract for 23,480 ft. 6-15-in. san. sewers in Dunedin Rd., at $39,018.

Ohio, Hamilton—The W. M. Davis Co., local, awarded contr. for laying san. sewers in Armondale subdiv. at $40,573; Badger Meter Co., Milwaukee, Wis., also awarded contr. for water meters.

Okla., Okla. City—Smith Bros., Dallas, Tex., awarded contr. to construct Lee Ave. sewer at $490,309.

Pa., Philadelphia—Following contracts for sewer construction in various streets let by Direct. of Dept. Pub. Wks.: Fred T. Ruckius, Jr., Allengrove, at $36,000 (portions of 5 streets); Antony A. Pastore, at $36,000 (7 streets); A. J. Ellis, $4,000 (1 st.); D. Delise, $12,700 (3); A. Disandro & Son, $13,000 (3); Emilio Pascuzzi, $18,500 (2); M. Mattia, $8,000 (2); F. Borelli, $1,100 (1) and Nicholas Ferraro, $2,000 (1).

S. D., Sioux Falls—Michael Fanebust, Sioux Falls, awarded contract for sewer construction here at $49,500.

Wn., Seattle—V. Ramaglia, awarded contract for sewers and paving in Woodrow Pl. at $3,115 (clay pipe); Interstate Constr. Co. contr. for sewers in 32nd Ave. S., et al, at $36,775.

Wis., Milwaukee—Paul Riesen's Sons awarded contr. for erecting superstruct. of power house and boiler house for sewage disposal plant on Jones Island at $211,890.

Wis., St. Croix Falls—Hedborg & Heiner, care Toltz, King & Day, Engrs., 1410 Pioneer Bldg., St. Paul, awarded contract for 22,238 lin. ft. san. and 3,096 lin. ft. storm sewers, inlets, sewage treat. plant, manholes, appurts. etc., at $57,000.

WATER SUPPLY AND PURIFICATION.

Ala., Tuskegee—Noland-Clifford Co., Inc., Newport News, Va., award. contract by U. S. Hosp., at approx. $325,000 for constr. and equipt. of boiler plant consisting of 5 boilers, 150,000-gal. steel tank and tower constr. of sewage disp. plant, water system, central heating plant, etc.; also sub-contr. for bldg. 4 deep wells, each 500 ft. and bricking up 5 boilers.

Ariz., Prescott—S. P. Gillis, Engrg. Co., P. O. Box 454, Phoenix, Ariz., awarded contract for constr. of conc. dam in Banning Creek to impound water for City at $79,784. Work involves 800 cu. yds. rock excav. at 33c yd.; 9,600 cu. yds. cyclopean masonry at $8.25 yd. Dam will be a straight gravity type dam, 65 ft. high with vert. upstream face.

Cal., Presidio—(San Francisco, P. O.)—J. W. Roberts, P. O. Bldg., San Francisco, awarded contr. for pumphouse, pump equipt. and fire protection sys., at Marine Hosp. here, from Eng. Structs. Co., Call Bldg., at $21,580; Schultz Constr. Co., 46 Kearney St., $23,500; Burnham Plumbg. Co., 1220 Webster St., $23,900. Above contractors located in San Francisco.

Ont., Islington—Following contracts let for water works system in Area 3, Twp. of Etobicoke; abt. 3 mi. 6-in. cast iron pipe: pipe laying to Grant Contg. Co., 50 Front St., E. Toronto; pipe to Natl. Iron Wks., ft. of Cherry St., Toronto; valves to Drummond McCall Co., 373 Front St., E., Toronto; hydrants to J. T. Hepburn, 18 Van Horne St., Toronto. Engr's. estimate, $60,000.

Que., Montreal—E. G. M. Cape & Co., 10 Cathcart St., awarded contr. for 25,00,000-gal. rein. conc. reservoir, 500 ft. sq., 18 ft. deep, at $575,000.

Ia., Waterloo—C. H. Werner, Waterloo, awarded contract for 2 rein. conc. reservoirs, at $43,000. City will buy cast iron pipe.

D. C., Washington—Philip Agrios, New York City, awarded contract for constr. of water mains for Sec. 3, and Martin's Additions to Chevy Chase and Woodmont, at $73,765.

Fla., Vero—Edw. G. Ladd, Jacksonville, Fla., awarded contract to construct water works system at abt. $51,197.

Me., Auburn—Contract for extending water sys. let to F. A. Rumery Co., 21 Portland St., Portland, at $17,253; 1,200 tons c. i. pipe to Donaldson Iron Co., Emaus, Pa., at $48.70 per ton, specials, $0.055 per lb. Engr's. est. over $50,000.

Md., Cumberland—Cumberland Contg. Co., 62 3rd Natl. Bank Bldg., awarded contract for laying water conduit; engr's. est. $100,000.

Mich., River Rouge—Grfeiling Bros. Co., E. Walnut St., Green Bay, Wis., awarded contract for submerged water main across Rouge River abt. 40 ft. below water surface, 500 ft. 30-in. c. i. pipe, at $46,000.

Minn., Winona—T. Woolley & Son, LaCrosse, Wis., awarded contr. for extension of water main, 14,774 lin .ft. 6-10-in. C1. D cast iron pipe, 10,812 lbs. stand. C1. D c. i. castings, etc., at $31,587.

Miss., Durant—Bobo & Collier, Memphis. awarded contr. for installing sewer system at $16,500; J. M. Evans, Jackson, contr., for laying water pipes and installing hydrants for water sys. at $10,278; Chicago Bridge & Iron Co., Chicago, contr. for erecting tower and tank, at $4,564; U. S. Cast Iron Pipe Co., Birmingham, Ala., contract for cast iron pipe, at $19,000.

Mont., Red Lodge—McLaughlin & O'Neil, Livingston, awarded contr. for 13,020 ft. 6-8 and 10-in. c.i. pipe, 8,900 ft. 8 or 10-in. cast iron pipe, 1 clear well and 2 pressure regulators, at $63,106.

N. J., Trenton—H. E. Stahl, Goodwill Pl., awarded contr. for installing I Ames Unaflow engine, 1 rotary pump, elec. generator, condenser, etc. in pumpg. plant, at $58,989.

N. C., Asheville—E. T. Belote, Asheville, awarded contr. for repairing city reservoir on Beaucatcher Mtn., at $40,595.

N. C., Goldsboro—B. McKenzie, Greensboro, awarded contract for water pumping equip., power plant piping and apparatus, at State Hosp. for Negroes, at $134,000.

N. C., Hendersonville—Kelly & Wilson, Asheville, awarded contr. for construction of water system, at $181,000.

N. C., Kernersville—Following contracts let: Constr. of 100-ft. tower and tank to R. D. Cole Mfg. Co., Union, Ga.; 2 deep wells to Cummings & Williams, Kernersville; water works and sewage sys. to Boyd, Higgins & Goforth, Charlotte, at total of $100,000.

N. C., Mt. Holly—W. A. Everett, Charlotte, awarded contr. for constr. of water works and sewerage systems, at $75,000.

N. C., Morganton—Boyd, Higgins & Goforth, Charlotte, award. contract for 12 miles 12-in. c. i. bell and spigot water pipe from reservoir to standpipe, at $195,000.

N. Y., Buffalo—Thompson-Starrett Co., 49 Wall St., New York, awarded contract for filtr. plant structures. Contr. No. 1, at $1,800,480.

N. Y., Irondequoit—W. G. Fritz Co., W. Orange, N. J., awarded contr. for 30,000 ft. 6 and 8 in. mains, hydrants, valves, etc., here, at $48,760.

N. Y., St. George—M. DeStefano, 257 Glenn Ave., Tomkinsville, awarded contract for mains in Cary, Carter, Columbus Sts., etc. ,at $15,061; Barton, Bayview, Bedell, Bogardus, Centre, Egan etc., at $49,892.

O., Columbus—Pitt Constr. Co., Fulton Bldg., Pittsburgh, Pa., awarded contr. for 1,260 ft. 12-in. cement and 1,470 ft. 6-in. mains, at $12,144.

Okla., Bristow—Gibson & Mitchell, Pauls Valley, awarded contr. for extending water works at $46,018.

Okla., Okla. City—U. S. Cast Iron Pipe Co., Am. Trust Bdg., Birmingham, Ala., awarded contract for 6,000 tons 4-30-in. cast iron pipe, specials, valves, hydrants and valve boxes, at $202,460.

Okla., Wewoka—Yates & Gallamore, Cushing, Okla., awarded contr. for water works impvts., consisting of filtr. plant, intake and repairing dam, at $38,524.

Okla., Wilburton—Ladd Construction Co., Kansas City, Mo., awarded contract for extending water and sewer sys., at $175,000.

S. C., Honea Path—Henry Constr. Co., Greenville, S. C., awarded contr. by Chiquola Mfg. Co., for constr. of water and sewer systems for 132 dwellings; R. D. Cole Mfg. Co., Newman, Ga., awarded contract for steel tank on trestle.

Tenn., Lebanon—Tennessee Mfg. & Constr. Co., Lebanon, award. contract to construct water and sewer systems, at $220,000.

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Air Lift Pumps.
Harris Air Pump Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitoslag Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Littleford Brothers.

Auto Fire Apparatus.
Diamond T Motor Car Co.
Duplex Truck Co.
Garford Co., The.
Kissel Motor Car Co.
International Motor Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Back Fillers.
Austin Machinery Corporation.
Pawling & Harnischfeger.

Bar Cutters and Benders.
Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Trailer and Body Co.
Littleford Brothers.

Braces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.

Buckets, Dredging, Excavating and Sewer.
Pawling & Harnischfeger.

Buckets, Dumping.
Littleford Brothers.
Pawling & Harnischfeger.

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement Testing.
Kirschbraun, Lester.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Central Heating Plants.
American District Steam Co.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.
Littleford Brothers.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Machine Co.
Smith Co., T. L., The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Carey Co., Philip, The.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Conduits, Wood, Creosoted.
Republic Creosoting Co.

Consulting Engineers.
Alvord, John W.
American Appraisal Co.
Artingstall, Wm.
Brossman, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Gannett, Seelye & Fleming Co.
Hill & Ferguson.
Howard, J. W.
Hunt & Co., Robert W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Luten, Daniel B.
Morse, Wm. F.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The
Good Roads Machinery Co., Inc.
Koehring Machine Co.
Littleford Bros.
Smith Co., T. L., The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling & Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Molds.
Austin-Western Co., Ltd., The

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Direct Oxidation Process.
Direct Oxidation Process Corp.

Disinfectants.
Integrity Chemical Co.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg Co., W. E.

Drawing Materials.
Kolesch & Co.

Dryers.
Cummer & Son., The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

Texas, Childress—F. P. McElwrath, Corsicana, awarded contr. for dam, spillway, etc. (Item 1) at $144,546; pipe line, pump house, etc. (Item 2) to Hamilton Bros. Constr. Co., Taylor, at $177,124.

Va., Ashland—J. L. MacGhee Constr. Co., Tarboro, N. C., awarded contract for furnishing and laying 4 miles Cl. B 8-10 in. iron mains; 25,000-gal. steel tank and tower to C. D. Cole, Newman; Pittsburgh-Des Moines Steel Co., Curry Bldg., Pittsburgh, award. contract for settling basin, two 80-gal. steel tanks and tower, filtr. plant, 2 triple pumps.

Vt., No. Bennington—J. Long, Leominster, Mass., awarded contr. for water supply and sewerage system, including dam and collecting pond, 2,225,000 gal. distributing reservoir. (Temporary address of contractor, So. Shaftsbury, Vt.) Engr's. est. $200,000.

Wn., Walla Walla—Puget Sound Bridge & Dredging Co., Seattle, award. contract to complete water works impvts., at $132,715.

Prospective Work

ROADS AND STREETS

Cal., Fresno—City Engr. Wm. Stranahan has completed plans and specfs. for impvt. of Faris Ave. bet. Belmont and Olive Aves., involving 107,610 sq. ft. grading, 98,204 sq. ft. asph. paving, 9,030 sq. ft. conc. gutter, 287 lin. ft. 12-in. culvert, 196 lin. ft. 18-in. culvts, 12 manholes.

Colo., Ft. Collins—Sentiment strongly in favor of issuing $6,000,000 bonds for road impvts. in state, to meet similar amt. of fed. aid.

D. C., Washington—More than a dozen streets, in various sections of city, will be paved. Sheet asph. and conc. will be used.

Fla., Pensacola—Fourteen blks. paving in city will be recommended by Street Commr. F. Sanders. Est. cost abt. $50,000.

Fla., Sebring—Highland County plans bldg. main trunk line from Polk Co. to Glades Co. with laterals to Kissimmee River, Cressville and Hardee Co. line. May vote on $500,000 bonds.

Fla., Tallahassee—City Attorney instructed to draw up Ord. for elec. to vote on issue of $125,000 for street paving and $20,000 for sewerage impvts.

Fla., Tampa—Hillsborough Co. will lay abt. 151 miles hard surfaced roadways. $3,000,000 bonds voted.

La., Baton Rouge—E. Baton Rouge Parish Police Jury, Ward No. 4, contemplates laying 8 mi. Samuel Rd.—Baker canal to Parish line; 11 mi. East and West Rd.—Mt. Pleasant to Comite River through Zachary; 7 mi. Bayou Sara Rd. from Ward line; 4 mi. rd. from Zachary to Parish line. Will vote on $125,000 bond issue.

La., New Orleans—State Hwy. Comn. has started surveys and will also prepare bidders' specfs. for proposed temp. rd. at Poydras to connect Terreaud-Boeuf Hwy. with St. Bernard river sect.

La., New Orleans—Commission Council voted favorably on Commr. Black's plan to enlarge 1923 paving program. Revised program provides for paving 51 streets stretching 17 miles. Est. cost $400,000.

Mass., Boston—City will pave 1,200 alleys, having only earth surface. Work will begin in South end and $50,000 has been appropriated for this work. To pave entire 1,200 will cost approx. $2,000,000.

Mich., Detroit—More than $500,000 will be expended this year on improving roads of Essex Co. Work includes widening River Front Rd. bet. Ojibway and Amherstburg.

Mich., Monroe—$100,000 bond issue voted favorably here for paving. All streets will be paved.

Mo., Malden—Prelim. steps taken to pave practically every street in town. Bids will be asked soon. At mass meeting of citizens it was voted to pave residence streets with gravel 24 ft. wide and the 3 business blocks with conc. or asph. J. R. Woffard, Town Clk.

Mo., Jefferson City—State Hwy. Comn. has approved 13 local rd. projects covering total of 53 miles to be built at est. cost of $263,007.

Neb., Omaha—Pub. Impvt. program of $4,500,000 for paving, sewers and sidewalks is mark that City Commr. Jos. Koutsky has set for this season. One dist. of importance embraces Pierce St.—6th to 10th; 6th—Pierce to Hickory and 7th—Pacific to Pierce; the material to be of brick block. Est. cost $55,000. Lake St.—30th to 41st Sts.—will be paved with brick. Curbing will be started this month. This impvt. will cost abt. $59,000. Several street widening and opening projects are on the calendar. 175 paving contracts have been started this season or are ready for signatures.

N. Y., Broklyn—Orders given by Boro. Pres. Connelly (Queens) for impvt. of 10 streets in Queens. Total est. cost $200,000. Most important impvt. is paving with sheet asph. Cooper Ave.—Myrtle Ave. in Ridgewood section, to Brooklyn Boro. line. This impvt. will cost approx. $100,000. Another of the impvts. is paving with sheet asph. Liberty Ave.—104th to 109th Sts.—at est. cost of $50,000. In Astoria section 5th Avenue is to be paved with sheet asph. from Grand to Jamaica Aves.

N. Y., Watertown—Expendt. of county funds amounting to $276,950 and a distribution in 4 towns of $66,120 state aid funds for impvt. of network of hwys. throughout county, authorized in resolutions laid before Bd. of Supvrs. H. S. Ball, Co. Supt.

O., Columbus—Board of Co. Commrs. (Franklin County) have authorized Co. Surv. Lattimer to begin surface treating a number of important roads in County. Roads will be treated with Tarvia and Asphalt. Est. cost abt. $60,000.

O., Findlay—Seven miles paving will be built here this summer.

Ore., Pendleton—Approval of 1st resolution for 15 blocks of paving voted by Council.

Tex., Muleshoe—Bailey Co. Commrs. Court will call for bids abt. Oct., for 19 miles nat. sand clay rd. R. J. Klump, Co. Judge; G. L. Hasie, Engr.-in-Charge, Littlefield, Tex.

Tex., Newton—Will open bids about Oct. 15, for abt. 21 mi. state hwy. No. 7, Newton County, from Sabine River to Jasper Co. line east and west across County. J. E. Rausch, Co. Judge. (Work consists of gravel surfacing).

Tex., Paris—Lamar Co. contemplates gravel surfacing 6.06 mi. St. Hwy. No. 5—Red River Co. line to end of present Fed. Aid Proj.at cost of $41,500; gravel surf. 9.89 mi. State Hwy. No. 19, from point no. of Paris to Red River Co. line; fed. aid granted, $63,500; gravel surfacg. 11.16 mi. State Hwy. No. 5, from Fannin Co. line east toward Paris, $76,300; surface 9.24 mi. St. Hwy. No. 19 from Delta Co. line no.; gravel top; sledge limestone base; $74,122. W. L. Hutchinson, Co. Judge; W. M. Fooshel, Co. Engr.

Tex., Sinton—San Patricio Co. plans impvt. of east branch State Hwy. No. 9, $120,000; St. Hwy. Comn. granted $60,000 Fed. Aid. J. C. Houts, Co. Judge, Sinton; A. C. Pancoast, Co. Engr., Beeville, Tex.

Va., Suffolk—Nansemond Co. plans laying 5 mile conc. rd. bet. Suffolk and Franklin. Let contr. soon.

W. Va., Wheeling—City has decided to pave 1,000 ft. of Warwood Ave.

SEWERAGE AND SEWAGE TREATMENT

Cal., Calipatria—Plans being prepared for constr. of 21,600 lin. ft. 6-12 in. vit. pipe sewers in Assessment Districts 2 and 3. $32,000. H. Tsheppe, Co. Engr.

Cal., Los Angeles—Finance & Health & Sanitation Comm. of Council voted to adopt proposed sewer right-of-way agreement bet. Los Angeles and Culver City, and appropriate at once $465,000 for sewer pipe line and treat. plant to be constructed southeast of Culver City. Contrs. for land, laying pipe and constructing treat. plant will be let immediately. This emergency pipe line will handle

BUYERS' GUIDE

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Dynamite.
E. I. du Pont de Nemours & Co., Inc.

Edge Protector.
Truscon Steel Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Elevators.
C. H. & E. Mfg. Co.

Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Engines.
C. H. & E. Mfg. Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling & Harnischfeger.
Sauerman Bros.
Smith Co., T. L., The

Expansion Joint Compound.
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co.

Fence, Iron.
Cincinnati Iron Fence Co.

Fillers (Paving Joint).
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms (Sewers & Conduits).
Heltzel Steel Form & Iron Co.

Forms (Wall Bldg., Construction, Etc.).
Heltzel Steel Form & Iron Co.

Gas Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Graders.
Austin-Western Road Machin-
Good Roads Machinery Co., Inc.
ery Co.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gravel Screener and Loader.
Good Roads Machinery Co., Inc.
Jordan & Steele Mfg. Co., Inc.

Heaters (Rock and Sand).
Littleford Bros.

Heating Plants, Central.
American District Steam Co.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling & Harnischfeger.

Hoists, Electric .
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
Mead-Morrison Mfg. Co.

Hot Mixers.
F. C. Austin Machinery Co.

Hydrants.
The Flower Company.

Incinerators.
William F. Morse.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Joint Fillers (Paving).
The Barrett Co.
Carey Co., Philip, The.
The Texas Company.

Kettles (Portable).
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Loaders.
Brown Portable Conveying Machinery Co.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
The Barrett Co.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corporation.
Koehring Machine Co.
T. L. Smith Co.

Mixers—Mortar.
C. H. & E. Mfg. Co.

Molds (Pipe & Culvert).
Heltzel Steel Form & Iron Co.

Motor Fire Apparatus.
Acme Motor Truck Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Trucks.
Acme Motor Truck Co.
Duplex Truck Co.
Federal Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Truck Flushers, Sprinklers and Oilers.
Acme Motor Truck Co.
Austin Machinery Corporation.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
The Gramm-Bernstein Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Muhicipal Castings.
Dee Co., Wm. E.
Madison Foundry.

Packing.
Pioneer Asphalt Co.

Paints (Asphalt).
Barrett Co., The
Pioneer Asphalt Co.

Paving Blocks (Creosoted).
The Barrett Co.
Republic Creosoting Co.

Paving Brick.
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
National Paving Brick Mfrs. Assn.
Springfield Paving Brick Co.

Paving Contractors.
Warren Bros. Co.

Paving Joint Compound.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Joint Filler.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Machines.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

Paving Plants (Asphalt).
Austin Machinery Corporation.
Cummer & Son, The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Smith Co., T. L., The
Warren Bros. Co.

Pipe Cutters.
W. W. Stickler & Bros.

Pipe Dip and Coatings.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

Pipe Manufacturers.
U. S. Cast Iron Pipe & Fdy. Co.

Pitch Filler.
The Barrett Co.
Warren Bros. Co.

Plows (Rooter and Wing).
Austin-Western Road Mach. Co.

Portable Paving Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.
Warren Bros. Co.

Portable Stone Bins.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Powder (Blasting).
E. I. du Pont de Nemours & Co., Inc.

excess sewage from southwest part of City for next 3 yrs. $12,700,000 sewer bond issue will be presented to voters at Aug. primary and if carried will provide for additional treat. plants and new outfall sewer to the sea.

Ont., Hamilton—City considering sewage disposal system to cost $2,500,000. James, Proctor & Redfern, 36 Tor. St., Toronto, Engrs.

Que., Three Rivers—Plans being prepared for sewer to cost $32,000 on Notre Dame St., for City. C. Gelinas, Engr.

D. C., Washington—Dist. Commrs. 509 Dist. Bldg., plan to lay sewers in various streets, $250,000 appropriated.

Ky., Hazard—Town will install sewerage system, not including sewage disposal plant. Est. cost $50,000. A. G. Taylor, Clk.

Md., Williamsport—Voters have authorized bond issue of $117,930 for extensions to city sewer system.

Mass., So. Boston—(Boston, P. O.)—City plans rein. conc. overflow sewer in Farragut Road extension. $43,300. J. J. Carty, City Hall, Engr.

Minn., Waseca—Plans under way for sewage disposal plant and impvts. Cons. Engr. W. E. Buell & Co., Davidson Bldg., Sioux City, Ia. Jno. Madigan, Clk. Est. $75,000.

Neb., Papillion—Will probably take bids in near future for sewer and water works. Cons. Engr. Rohrborough Engrg. Co., 929 City Natl. Bk. Bldg., Omaha. Geo. F. Oliver, City Clk. $10,000.

N. J., Newark—Est. cost of proposed storm sewer in Hillside, $99,629. Twp. Engr. Wm. H. Luster.

N. M., Artesia—Constr. of sewer system at approx. cost of $500,000 is contemplated.

Ohio, Lima—City Comn. has enacted legislation authorizing 3 storm water relief sewers to cost $800,000 affecting a dozen streets.

Tex., Houston—City will soon receive bids for 10,000 ft. st. sewers in Turner & Castle Ct. Addn. 12-57 in. vit. clay seg. blocks or conc. pipe. $80,000. J. C. McVea, City Engr.

Tex., Lubbock—$100,000 bonds voted here for sewerage extens. and impvts. S. Sanders, City Engr.

Va., Barton Heights—City has tentative plans for impvt. of sewers, streets, fire house, etc. $1,500,000 available.

Va., Petersburg—Plans being made and bids will soon be asked for 3 miles of sewers. $75,000. L. Budd, City Engineer.

Wis., Milwaukee—Plans for diversion of sewage from South shore beach into city sewerage sys., being completed and will be submitted to Sewerage Comn. shortly. Geo. F. Staal, City Engr. A plan for similar diversion at Bradford Ave. beach will soon be completed.

WATER SUPPLY AND PURIFICATION

Ark., Hot Springs—Prelim. ests. completed by Caddo River Power & Irrig. Co., for hydro electric proj. on Ouachita river near here. H. L. Remmel, Little Rock, Pres. 300,000 bbls. cement will be required.

Cal., East San Diego—City Council has ordered City Engr. E. Paul Ford, to prepare plans for water sys. under district plan. Entire system will be of cast iron pipe; mains to be 12, 10, 8 and 6 in. diams., while laterals or feed pipes will be 2 in. cast iron pipe.

Cal., Hermosa Beach—Election will be held the latter part of Aug. to vote on $150,000 bonds for water works and distributing system.

Cal., San Bernardino—Proj. to utilize waters of Lake Arrowhead for domestic and power purposes being promoted by Chambers of Commerce in San Bernardino, Redlands, Colton and Riverside, which have appointed committee to report on the matter. Lake Arrowhead Co. will join in enterprise as Victor Valley side of mountains can be irrigated from Mojave river on which it is proposed to construct dam at west fork, leaving all waters of lake for San Bernardino Valley. Est. cost, including power plants, etc., $2,000,000.

Cal., San Gabriel—$250,000 bonds voted by San Gabriel Co. Water Dist. at recent election. Present district includes portion of city of San Gabriel and adjacent county teritory—total of abt. 21,000 acres, on which there are about 4 wells from which water supply is secured. Part of supply also obtained from Van Nuys Water Company's properties near Raymond dike, Pasadena. Funds voted will be used to build pipe lines and rein. conc. reservoir. J. A. Bell, San Gabriel, Gen. Mgr. and Engr .of Dist.

Ont., Kirkland Lake—Tech Twp. Council plans constr, of water system costing $60,000 at Kirkland Lake and Swastika.

B. C., No. Vancouver—Plans prepared for storage reservoir and water mains to cost $60,000 for North Vancouver.

Conn., Berlin—Plans being prepared for 3½ mi. exten. to water supply sys. in Hudson St., Farmington Ave., Middletown Rd:, and Worthington bridge sections. Oldershaw & Crowley, 259 Main St., New Britain, Engrs.

Ill., Waukegan—Election in near future to vote on $940,859 bonds for filtration plant.

La., New Orleans—Sewer & Water Bd. has approved extensions of 16-in. water main on Canal St. and Canal Blvd.; 12-in. pipe extension from Scott St. to Adams Ave. Approx. cost $65,000.

La., Ponchatoula—City having plans prepared by Swanson-McGraw, Inc., 705 United Fruit Bldg., New Orleans, Cons. Engrs., for water works and sewer system. $125,000 approx. cost.

N. Y., E. Syracuse—Plans new reservoir of one million gal. capy., at est. cost of abt. $100,000. S. L. Adcock, Engr.

N. C., Charlotte—City considering erection of water plant. Wm. Platt, Cons. Engr., Durham. $300,000 available.

Okla., Cushing—City considering extension of water and sewer systems. Est. cost abt. $300,000.

W. Va., Wheeling—Council has approved report of the J. N. Chester Engineehs, in which recommendations were made that comb. filtr. and pumping plant be installed at Warwood; also that plant be steam driven. Council also authorized City Mgr. to secure options on land at head of Jonathan's ravine at First St., for location of the five 1,000,000 gal. reservoir steel tanks. Old plant at Slacktown will not be dismantled until new one is constructed.

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